OCT 8 1943

ELECTRONIC INDUSTRIES

- ★ Measuring Projectile Velocity with Vacuum Tubes
- ★ AF Filter Design ★ Electronic Oil Prospecting
- ★ Postwar Home Radio Sets ★ OWI New York Studios

OCTOBER
Caldwell-Clements, Inc.

Fast Service On Vital Maintenance Parts

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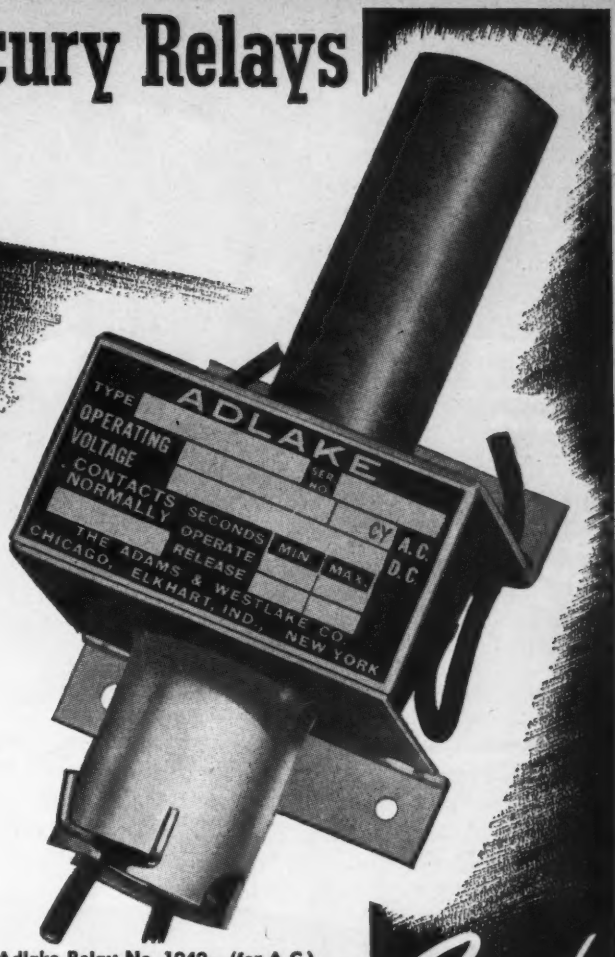
Adlake *Plunger-type* Mercury Relays

STAMINA
SIMPLICITY
DEPENDABILITY



Adlake Relay No. 1040—(for A.C.)
5¼" high, 2½" wide, 2⅛" projection. For panel mounting. Contact normally open or closed. Quick or time delay action. Contact protected by metal armor.

Automatic power control can be no more dependable than its relays. That is why the plunger type mercury relay is replacing other types. It is the most dependable relay thus far developed for many types of service, because dirt, dust, moisture, temperature changes, humidity etc. can not affect its hermetically sealed contacts.

ADLAKE Plunger-type Mercury Relays are available for either quick or time delay action . . . for A. C. up to 440 volts . . . for D. C. up to 115 volts (and higher, with outside resistors) . . . and contact capacity from a fraction of an ampere to 100 amperes. All operate on the same basic principle. All are armored against outside impact. All have *hermetically sealed mercury to mercury contacts* which are *positive, chatterless, noiseless* and *arcless.* For complete data, request bulletin.

Proved

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- Radio transmission
- Electric time controls
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- Remote and automatic controls
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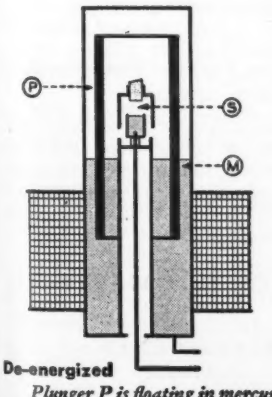
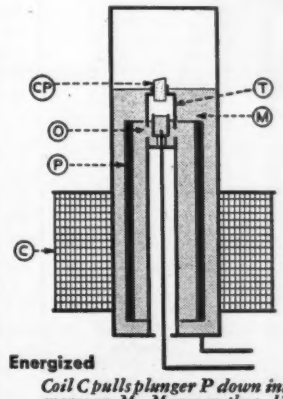
- Signals and indicators
- Refrigeration controls
- Voltage regulators
- Burglar alarms
- Electric call systems
- Across the line motor start switches
- Motor reversing switches
- Sign flashers
- Animated displays
- Telephone circuits
- Mill and factory service
- Navigation buoy flasher light controls
- Dry cleaning equipment
- Surgical lighting controls
- Electrolysis prevention
- X-ray control

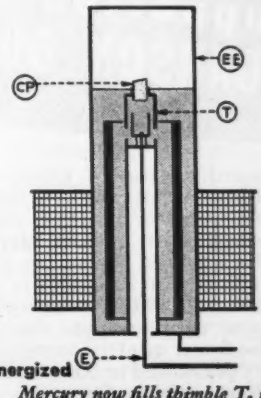
SIMPLE, UNFAILING, POSITIVE ACTION



De-energized
Plunger P is floating in mercury M. Space indicated by S is filled with inert gas.



Energized
Coil C pulls plunger P down into mercury M. Mercury thus displaced enters thimble T through orifice O. Inert gas in thimble has not yet escaped through ceramic plug CP, thus effecting time delay.



Energized
Mercury now fills thimble T, is completely leveled off and mercury to mercury contact established between electrodes E and EE. Degree of porosity of plug CP determines length of time delay—and accurately.

The above and accompanying sketches are not mechanical drawings. They show how Adlake Relays work, not construction detail.

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE HERMETICALLY SEALED MERCURY RELAYS FOR TIMING, LOAD, AND CONTROL CIRCUITS

LISTED ON PAGE 4, EDITORIAL CONTENTS AND ARTICLES

PAN-AMERICAN
Safety
supported by
THORDARSON QUALITY

Coordination of effort in building airplanes... in flying them over the skyways, and in landing them at the airports of the world is the secret of the fine record for safe flights made by PAN-AMERICAN airways.

By the same token, the use of only the finest quality parts in building every plane and in constructing the mechanisms which direct its comings and goings, is another very important factor in promulgating complete safety.

That is why Thordarson transformers were selected by PAN-AMERICAN airways for important uses in the planes themselves as well as for use in control tower operations, where dependability and quality of material are of such great importance.

ARMY E NAVY

THORDARSON

ELECTRIC MFG. COMPANY
500 W. HURON ST., CHICAGO, ILL.

Transformer Specialists Since 1895

ORIGINATORS OF TRU-FIDELITY AMPLIFIERS

ELECTRONIC INDUSTRIES

OCTOBER, 1943

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ELECTRONIC INDUSTRIES

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Better Post-War Production Design

Returning soldiers, used to handling high-quality radio and other equipment, are going to be critical of civilian "junk" when they see it. And the rest of the public—these soldiers' friends and relatives—are bound to be quite impressed by such comments. All kinds of radio-electronic apparatus will therefore have to be better designed, better built, better equipped, to get and hold respect.

Such apparatus will, of course, last longer. It will require less servicing. Resistors with a 200 per cent safety factor don't let go like those working "on the margin."

All this must mean higher original cost and higher retail price. But industry and the public will have learned that the answer to "why pay more?" is to get better, longer-lasting merchandise. Many products will be designed for maximum utility rather than maximum profit or sales volume. The radio-electronic industries, now working on rigid and precise military specifications, will have a considerable head start in the new type of post-war product design.

Inventiveness Can Be Overdone

We must, of course, marvel at the engineering ingenuity that issues from the industry's brain cells. But at the same time we are often prone to wonder just how much of this ingenuity represents any real advance in technique. Too often, design problems are solved in a way easiest for the designer, yet not as easy as might be for production. Frequently it is the "special" parts, newly designed to do a particular job, that run up costs, breed bottlenecks.

Again We Trim and Compress

This issue reaches the reader with more-closely-set and smaller type, and with page margins further trimmed—in an effort to furnish readers as much material as before, in the face of impending paper-tonnage reductions ordered by the Government. Though economizing on paper, we are determined not to curtail our editorial features or pages.

For while electronic manufacturing has increased 1200 per cent to 2000 per cent, the paper tonnage we are allowed to use per issue to serve this expanding field, is limited to a **diminishing fraction** of the paper we **used in our first infant issues of 1942!**

Radio departments of the Government urged the launching of a publication to render the unique war-radio service which we initiated. In fact the WPB's Radio Division endorsed our applications for increased paper allotments. But now other routine WPB regulations restrict the growing giant to the panties of his babyhood!

Why Can Others Double Their Size?

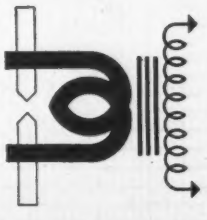
Readers have asked us how other publications continue to increase their size and use of paper, while we cannot. In each such case it can be explained that the magazine so enlarged utilizes paper allotments of other publications owned by the same publisher—magazines which have shrunk or have been discontinued. Unfortunately we have no such "lame ducks" to throw into our paper pool. And government regulations prevent us from acquiring such additional allotments by purchase.

That is why we now have to trim and slice and compress!

Next Month, *another valuable Electronic Industries chart in colors*—

ELECTRONIC WELDING

Our chart supplement for November will give a resumé of the advances in welding processes that have been made possible by the application of the precise control of electronic devices. The numerous fields of welding, the variations in the equipment and method to take care of material, type of junction and size of pieces, and such matters as the power availability, are all described and diagrammed in terms of physical equipment requirements, circuits, operating data.



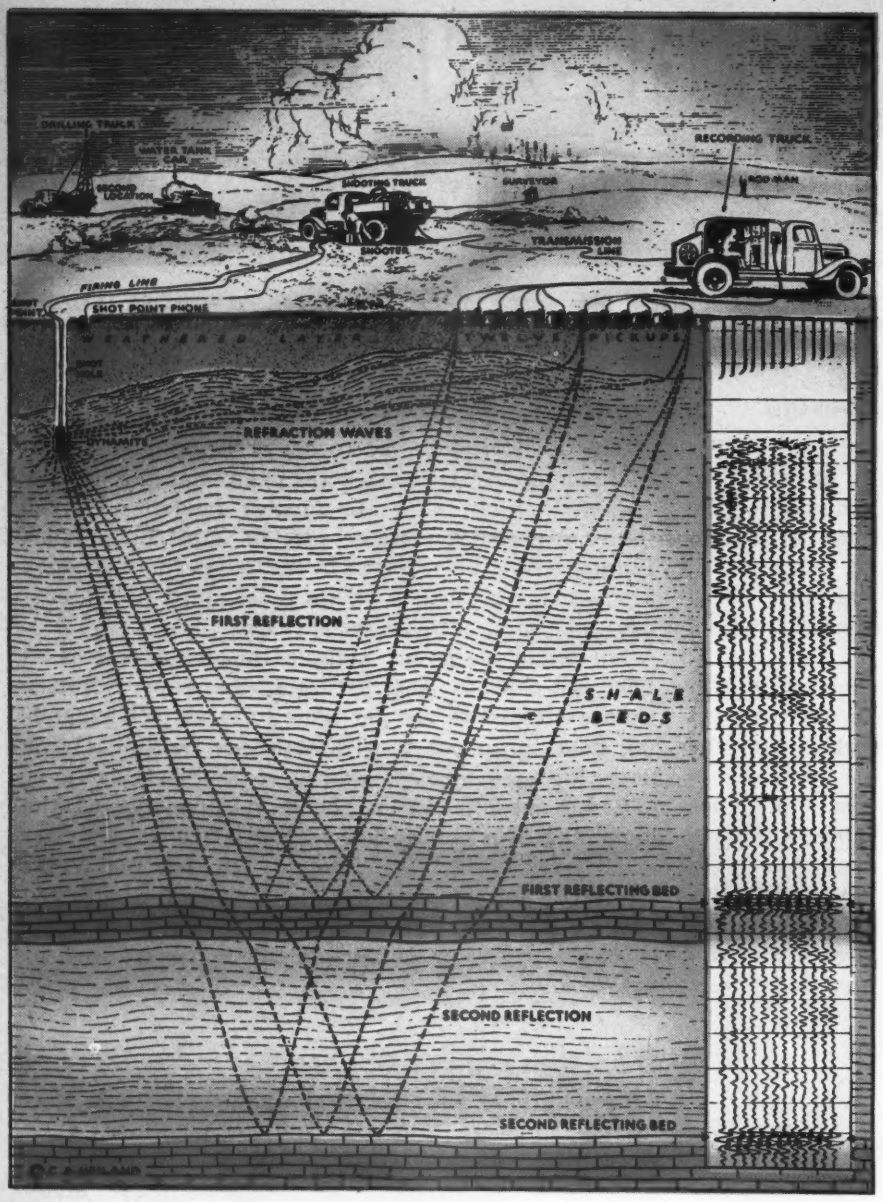
Seismic

by GILBERT SONBERGH

• Discoveries of new oil-producing areas in recent years have not been equal to annual consumption. Each year, of course, the discovery of new oil deposits becomes more difficult. The necessity for using the very best prospecting technique is apparent. During the last ten or fifteen years, development of the art of seismic prospecting has placed it in the forefront among the possible methods. Amplification of audio and subsonic waves by electronic means is the heart of the method.

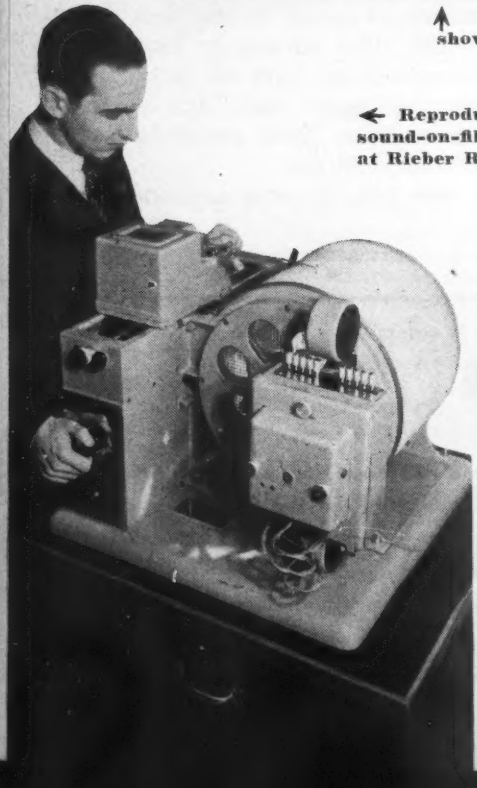
In seismic prospecting, a charge of dynamite of from one-half to ten pounds is detonated at the bottom of a four to six in. hole drilled 50 to 750 ft. below the surface of the ground. Elastic waves emanating from this "shot point" are transmitted through the ground in all directions. Those which are of chief interest travel downward, and are reflected from sub-surface strata and structures at various depths.

The reflected waves return to the surface to actuate pickups, commonly called geophones, placed at predetermined positions in relation to the shot point. The output voltages of the geophones are suitably amplified and fed to recording oscillographs, generally of the mirror-galvanometer, moving photographic paper type. The elapsed time between the shot instant and the reception of the reflections is recorded. Proper interpretation of the oscillographic traces enables accurate mapping, in three dimensions, of the local sub-surface structure of the earth's crust.

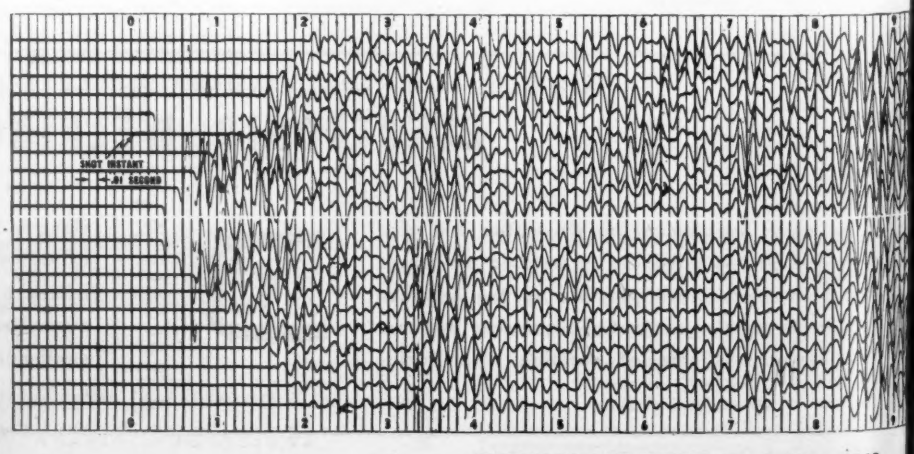


↑ Seismic reflection technic, showing wave-paths and record

← Reproducing reflections recorded as sound-on-film, with Sonograph Analyzer at Rieber Research Lab., New York



Sample seismogram. Ground motion recorded for two 1000-ft. each side of two-pound dynamite charge in hole



Prospecting

The oil industry's electronic divining rod

Thus, seismic exploration does not locate oil directly. It locates and defines the underground structures and materials known to be associated with the existence of oil deposits. The process must work hand in hand with geology — the practical geology of a region or local area as well as geology in general.

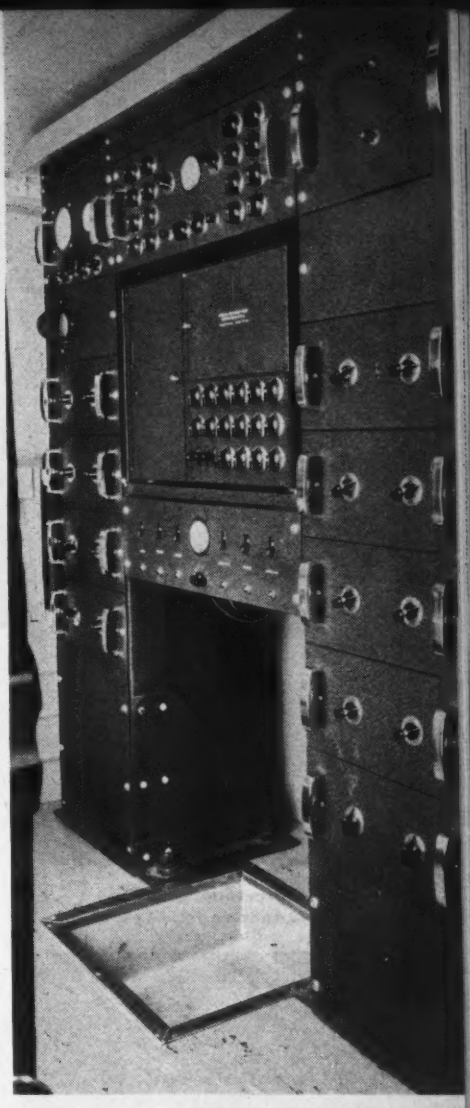
America's oil industry makes an annual expenditure of about 20 million dollars in seismic prospecting equipment and the skilled personnel of field parties to operate it. Probably that figure will increase rapidly as the search for oil becomes more intense. The average successful oil well's entire life-yield is used up on the Atlantic seaboard in a day or two. New wells must be drilled every day while fresh reserves for the future are being located. It is a little like digging for natural springs to put out a fire.

Formation of ore structures

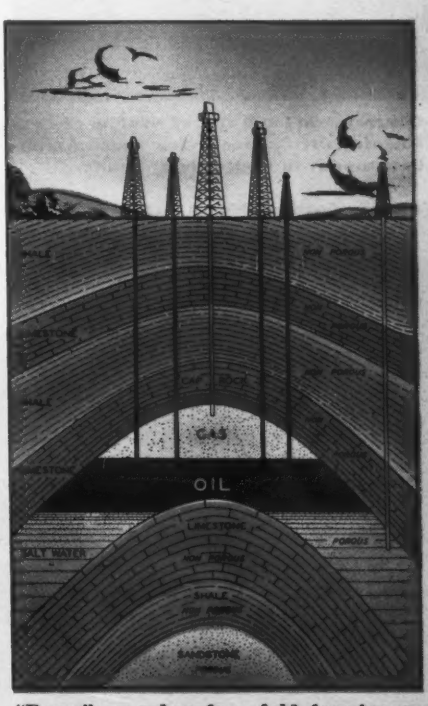
One theory of the formation of oil claims that it is the organic remains of prehistoric marine life which died and fell to the bottoms of inland seas. This matter was deposited in annual or some other cyclic layers, usually in an intimate mechanical mixture with sand or other porous material. Upheavals and settlings of the earth's crust through the ages have inevitably resulted in deformation, folding, faulting, or tilting, leaving high points in the many alternating layers of oil-bearing strata, sandstone, shale, limestone, etc. Such deformation of the earth's crust frequently left voids, or pockets of porous materials covered by non-porous "cap rocks." Since oil is lighter than water, the omnipresent ground water has gradually floated the oil up to the non-porous layers or domes which constitute the various types of structural traps. It is the problem of seismic prospecting to locate such underground traps.

Fortunately, the various types of material of these layers offer different degrees of impedance or radiation resistance to the passage of pressure waves originating from the small charge of high explosive. Refraction and reflection of the waves result at those planes where two adjacent layers have different radiation resistances. The electronic equipment associated with seismic prospecting may be compared to the high-quality sound or vibration amplifier, with certain notable distinctions.

The reflected waves from subsurface layers result in damped oscillatory movements of the ground's surface of the order of a millionth of an inch, at rather low frequencies. Pickups or geophones to detect such movements and generate voltages proportional to their velocity or amplitude must employ a spring — suspended inertia — mass mounting for the moving element. Various electrical principles have been widely used, including piezo-electric, capacity or condenser, photoelectric, carbon granule, magnetostriction, and hot-wire resistance types. The inductance and reluctance types, however, are almost universally used today. The former is comparable to a moving-coil dynamic type microphone, with the

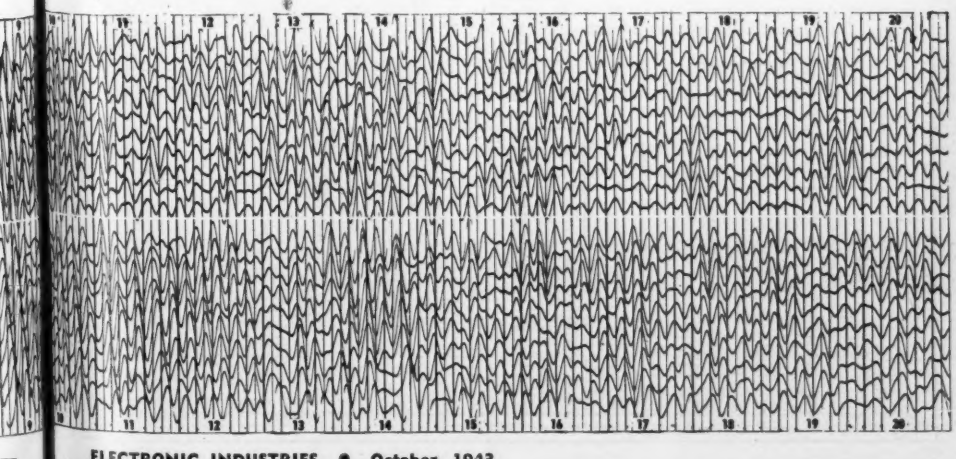


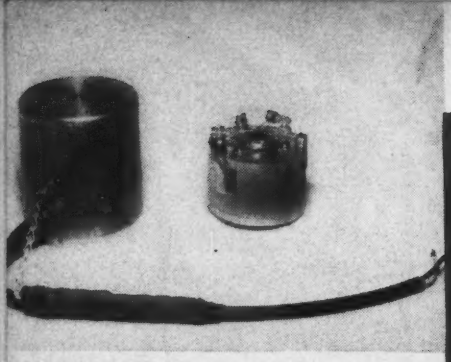
Nine dual amplifiers (one a spare) in 16-trace recording-truck installation of the Heiland Research Corp., Denver, Colo.



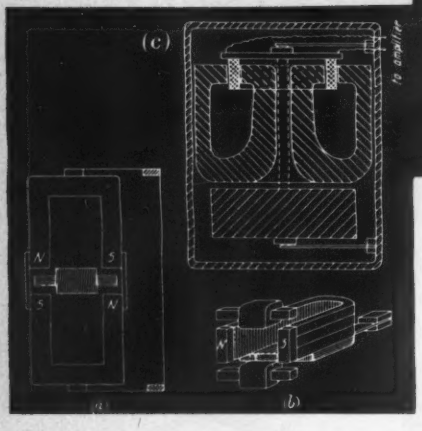
"Dome" or subsurface fold forming an oil-pool. "Dry hole" at right shows how easy it is to miss

seconds on geophones arranged in line at 100-ft. intervals 45-ft. deep. Courtesy United Geophysical Co., Pasadena, Calif.

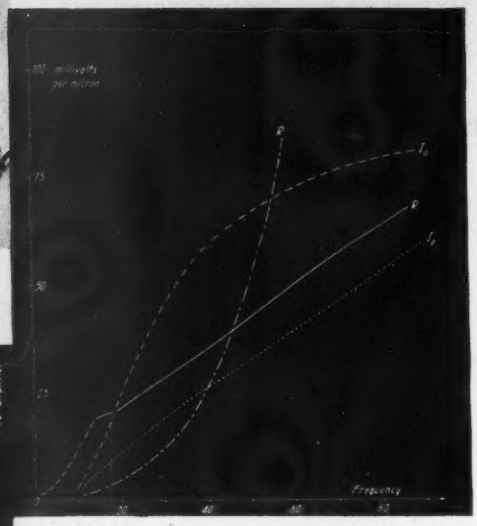




Electromagnetic inductance - type geophone, or ground-motion detector, used by National Geophysical Co., Dallas, Tex.



Reluctance detectors (a, b) and typical inductive type (c)



Voltage at grid of first amplifier tube in millivolts per micron ground motion (through impedance matching transformer) of commercial reflection detectors at various frequencies. R, reluctance types; I_o, inductive with oil damping; I_e, inductive detector electromagnetically damped. Heiland Research Corp.

diaphragm replaced by a cantilever or other type spring suspension.

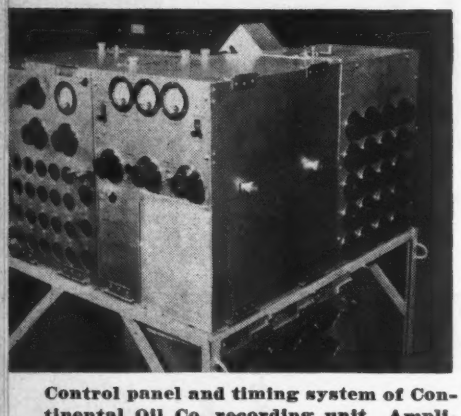
The housing of the geophone mounts the permanent magnet, and the earth motion causes the coil to move vertically in the air-gap. The natural mechanical frequency of such instruments is usually 8 to 20 cycles per second. Near-critical damping must be provided, usually by an external shunt resistor across the coil output. The electromagnetic, rather than the oil or fluid damping method common in earthquake - seismometers, avoids variations due to temperature fluctuations. A typical unit has a sensitivity of 800 microvolts per mil per second on open circuit, and practically flat response from 15 to 300 cycles. The reluctance type consists of a coil, usually wound on the permanent magnet, whose reluctance changes with movements of an iron armature in the air-gap.

Seismic prospecting involves the use of banks of 6 to 25 amplifiers, each of which is connected to one, two, or more geophones. These amplifiers are similar to conventional low-frequency units except for several rather unusual features. Three to five stages of transformer-coupled, resistance - impedance, or straight resistance - coupled voltage amplification are used.

Certain requirements are paramount. A high signal-to-noise ratio is required to minimize low frequency earth "grumbling," and high frequency noise from wind, birds, singing, etc. A sharp, distinctive signal must appear on the film, which means a fixed time relation to any arriving wave train. Any other waves interfere with additional reflections or other subsequent arrival of seismic waves. Including iron in any of the circuits has a general tendency to prolong the wave trains. Resistance-coupled amplifiers are usually preferred.

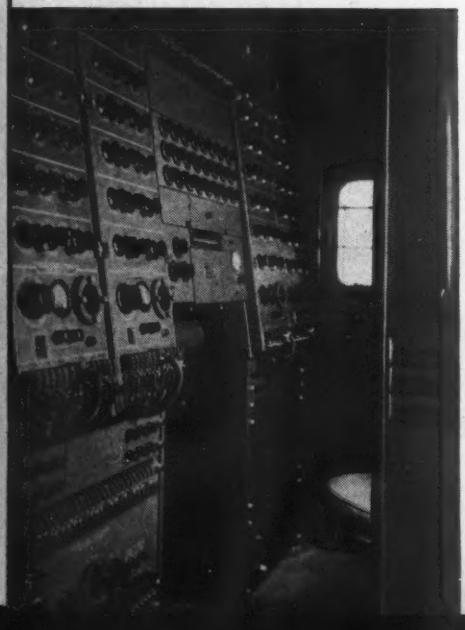
Because of the relatively high sensitivity of the mirror galvanometers used in the recording oscillographs, the power output required of the amplifier is low. A typical unit provides about one microwatt, 0.32 volt across 10^5 ohms.

The amplitude of the ground motion generated by an exploding charge of dynamite decays at the rate of 20 to 40 db per second. The first tube of the amplifier must, therefore, be able to accommodate a wide range of signal input without distortion. During the first few seconds after detonation of the explosive, the voltage on this grid may vary roughly between one volt and five microvolts, across a 0.25 megohm grid resistor.

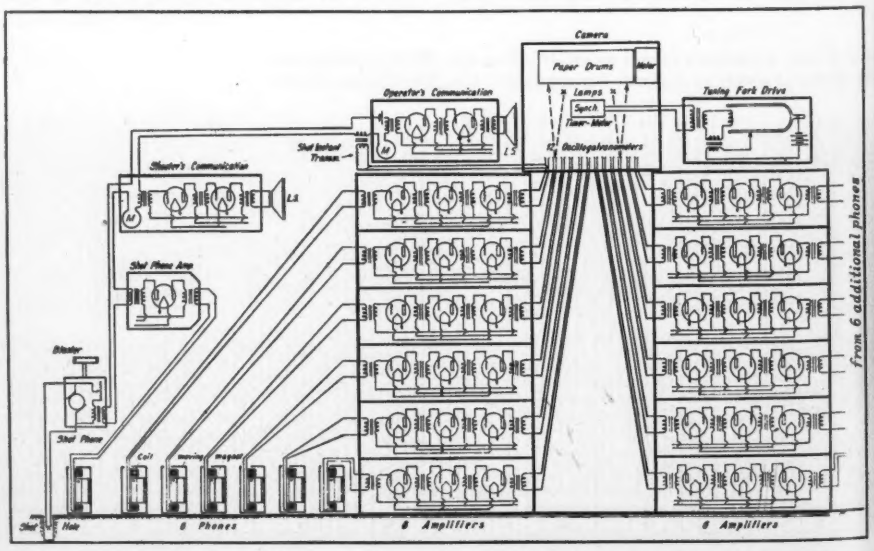


Control panel and timing system of Continental Oil Co. recording unit. Amplifiers mount in rack below

Twenty-four amplifiers and recorder in a National Geophysical Co. truck



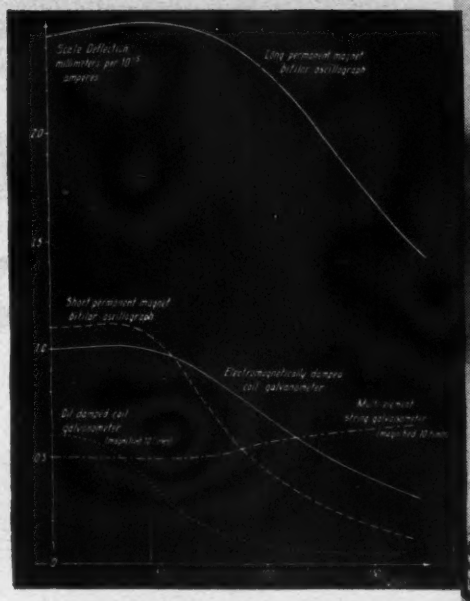
Simplified schematic diagram of complete Heiland 12-element system



The voltage output of the last tube, however, must remain constant within plus or minus six db, in order to provide usable amplitudes on the oscillograph trace for its entire length. The gain of the amplifier must therefore be varied in inverse proportion to the signal input. The decay of the signal input is usually so rapid that the gain could not well be varied manually. It is accomplished either by a preset automatic gain expander or by automatic electronic gain control circuits, or both. Since the decay of input energy is roughly exponential with time, the gain expansion required generally can be anticipated after a few preliminary trials in a given locality. The amplifier gain is then expanded at this rate by applying the exponentially decaying voltage across a discharging condenser as bias or the grids of pentode voltage amplifiers. The expansion required may range through 60 to 80 decibels.

A number of special circuits have been developed to provide constant output amplitude for input signal variations as great as 10,000 to 1, in a small fraction of a second. One ingenious method uses a resistance bridge, in the output circuit, two arms of which consist of flashlight bulbs. Balanced when cold, the "hot output" of the bridge is used as inverse feedback to cut the amplifier gain on the first shock. The lamps cool and the amplifier gain returns to normal in a few milliseconds.

In the case of automatic gain control circuits, part of the output signal is rectified, filtered, and applied as tube-bias to control the gain. Although similar to AVC systems in radio amplifiers, the problem is here complicated by the fact that it is desired to change the amplifier gain appreciably in a very few cycles of signal frequency. Hence, difficulties are encountered with tendencies of the amplifier to oscillate, and with undesirable forms of distortion.

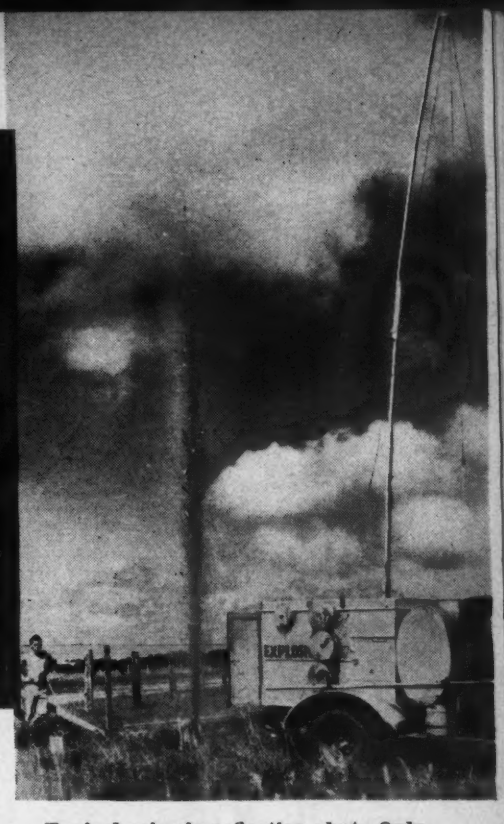

Scale Deflection millimeters per 10⁻⁹ ampere
Long permanent magnet bifilar oscillograph
Short permanent magnet bifilar oscillograph
Electromagnetically damped coil galvanometer
Oil damped coil galvanometer
Multi-element string galvanometer

Response of various commercial recording-galvanometers

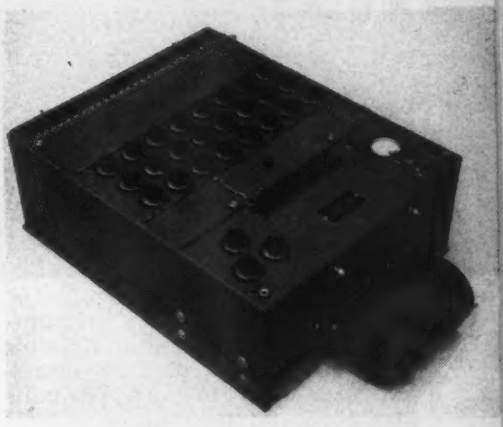
The range of signal frequencies is more limited than in audio-frequency sound amplifiers. By the use of suitable high and low-pass filters, the band is limited roughly to 20 to 150 cycles. However, unlike the sharp non-dissipative filters used in conventional networks, the filters used in seismograph amplifiers are generally heavily damped by shunt resistances, and do not have sharp discrimination at their limits. The signals recorded are impulsive in nature; long oscillatory transients, often associated with sharp cut-off filters, are therefore undesirable. Considerable attention is given both to phase-shift and frequency response characteristics in order to obtain desirable transient characteristics.

The amplifiers must be carefully watched as to filter characteristics

(*Continued on page* 196)



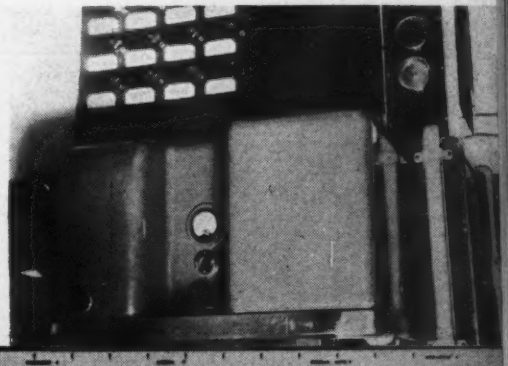
Typical seismic reflection shot. Only a small charge of dynamite is used



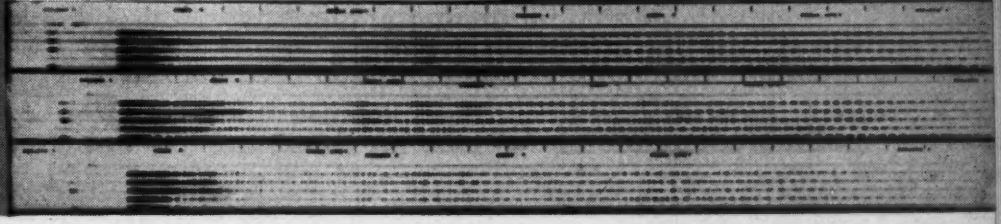
National 24-trace recording oscillograph

← Rear view of six-amplifier bank used by National Geophysical Co. Extra unit shown at right

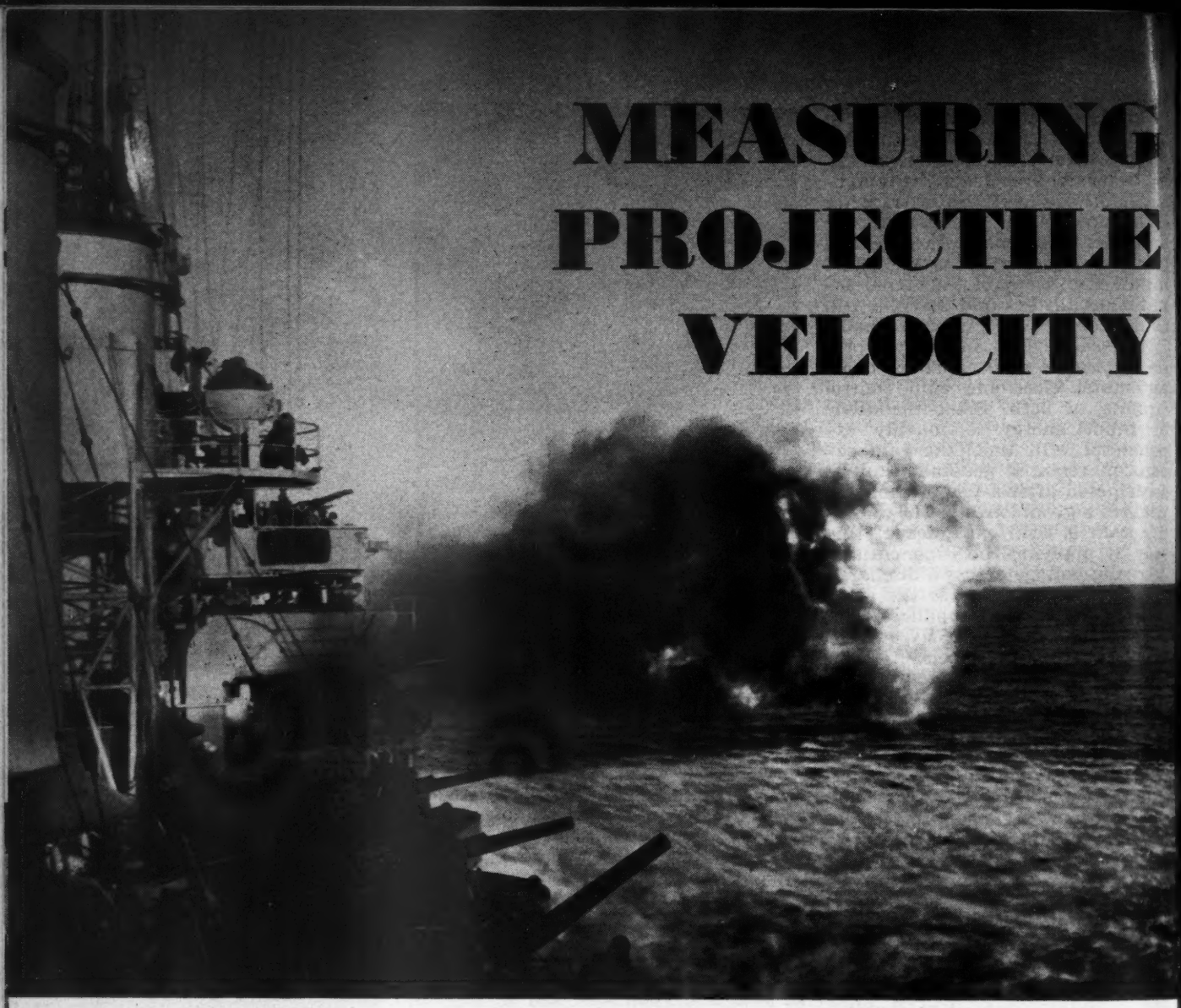
Sound-on-film recorder for the Rieber Sonograph system →



Sample prints from the reproducible Sonograph sound films



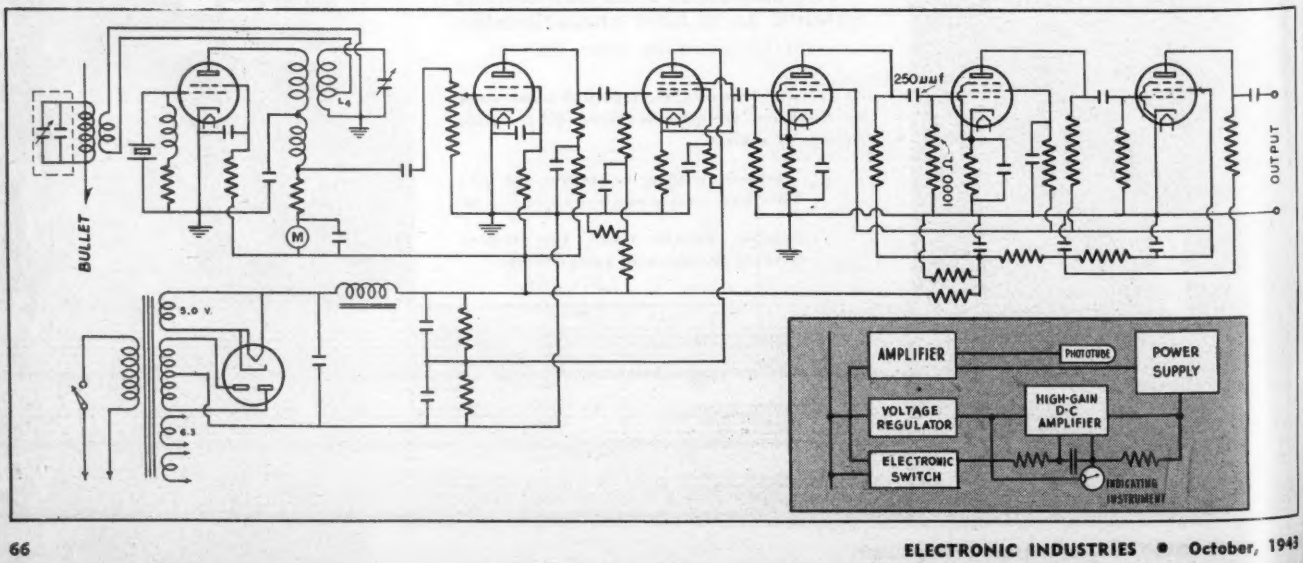
MEASURING PROJECTILE VELOCITY



• Accurate knowledge of projectile speeds is an essential factor in the design, production-control, and operation of big and little military arms and ammunition. Speed-measuring equipment operating on electronic principles is in almost universal use, by government as well as by private industry.

Measuring a bullet's speed over any part of its trajectory depends on recording the elapsed time interval during its passage through two points a known distance apart. In order to approach the ideal of measuring absolute velocity at a given point rather than average velocity during a longer flight, it is

Schematic of coil disjunctor, amplifier, and differentiating trip circuit to produce sudden voltage pulse when bullet reaches center of coil. Complete setup for velocity measurements includes two coil disjunctors and a chronoscope. Insert, block diagram of General Electric equipment for measurement of short intervals. Eight ranges are provided from 0.0001 to 3.0 seconds



desirable to keep the separation of the two points at a minimum. With the consequently shorter interval resulting from closer spacing, precise accuracy of the measuring equipment is required in order to hold the percentage of overall error to close limits.

In the Boulenge chronograph, an early device, the bullet or projectile broke two electrical contacts. The first released a vertically held metal bar or rod, while the second actuated a braking device to stop the fall. The distance of fall was calibrated in projectile speeds. Naturally, such a system involved inaccuracies due to mechanical and electromagnetic lags, and an error resulting from the physical impedance to the bullets' passage.

Electronic methods

Various electronic methods have been used both for securing the two timing impulses and for measuring the extremely short intervals between them. One method makes use of light-beams energizing phototubes. Another, used chiefly with heavy artillery, makes use of the voltage generated by a magnetized shell or projectile as it passes through two loops or coils of wire 150 to 300 ft. apart.

In testing small arms ammunition (caliber .50, .45, .30 and .22) the commonest method used to detect the passage of bullets in connection with velocity measurements is to energize a small coil with high frequency current. Self-contained oscillator and three coils are shown. The coil is link-coupled to the plate circuit of a detuned crystal oscillator.

As the bullet passes through the coil, the plate current of the oscillator tube increases. Suitably amplified and "clipped," to produce a steep wave-front output corresponding to the position of the bullet in the exact center of the coil, this voltage is used to trigger the time interval measuring device. The accuracy of triggering is illustrated in Fig. 2. The bullet was photographed in its tripping position by flashing a high speed single flash lamp with the output voltage of the coil disjunctor.

In one type of short time interval measuring device a thyratron is triggered which allows current to flow through a galvanometer. This, a ballistic galvanometer supplied by fixed batteries, is so designed that its pointer or mirror requires a greater interval to swing to full scale deflection than the interval to be measured. Another thyratron cuts off this current, by by-passing the first tube's anode current to lower the anode voltage below the ionization point, in response to the second impulse which may be derived from the bullet's passage through a second coil or its impact against a striker plate switch. The amount of galvanometer deflection during the time interval is proportional to the speed of the bullet.

Another instrument for the measurement of short time intervals in which refinements have been incorporated is the condenser

(*Continued on page* 196)

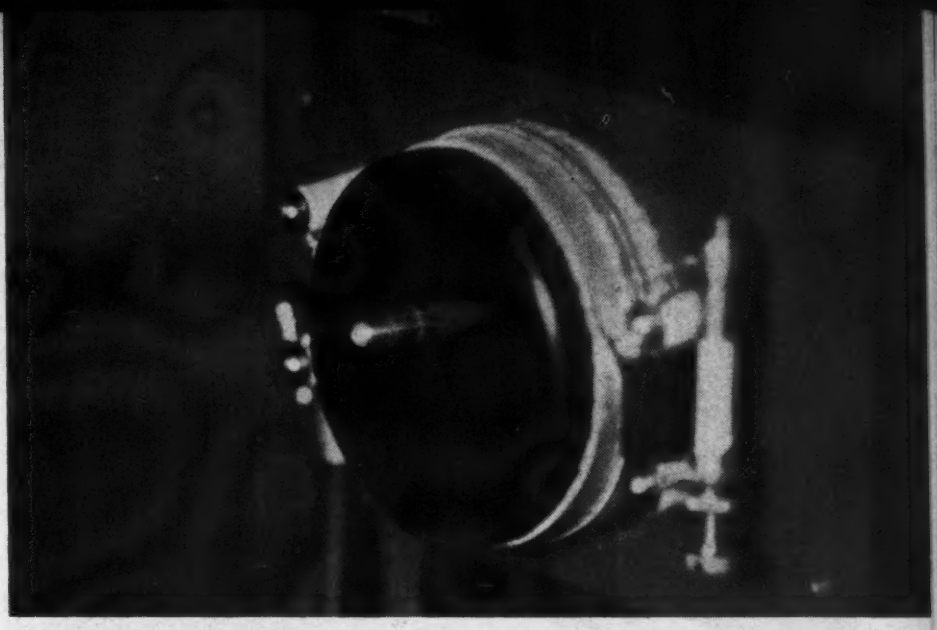


Fig. 2. High speed picture of a caliber .30 bullet at tripping position in a 3-in. coil

COVER ILLUSTRATION

The color photograph on the front cover, made by U. S. Navy photographers, shows the method by which projectile velocity is measured by firing a magnetized shell through two loops stationed a known distance apart.

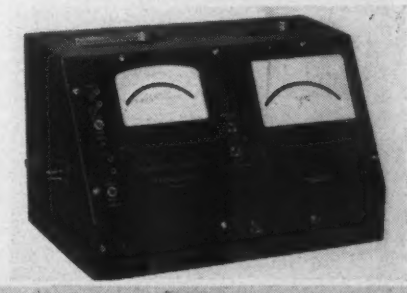
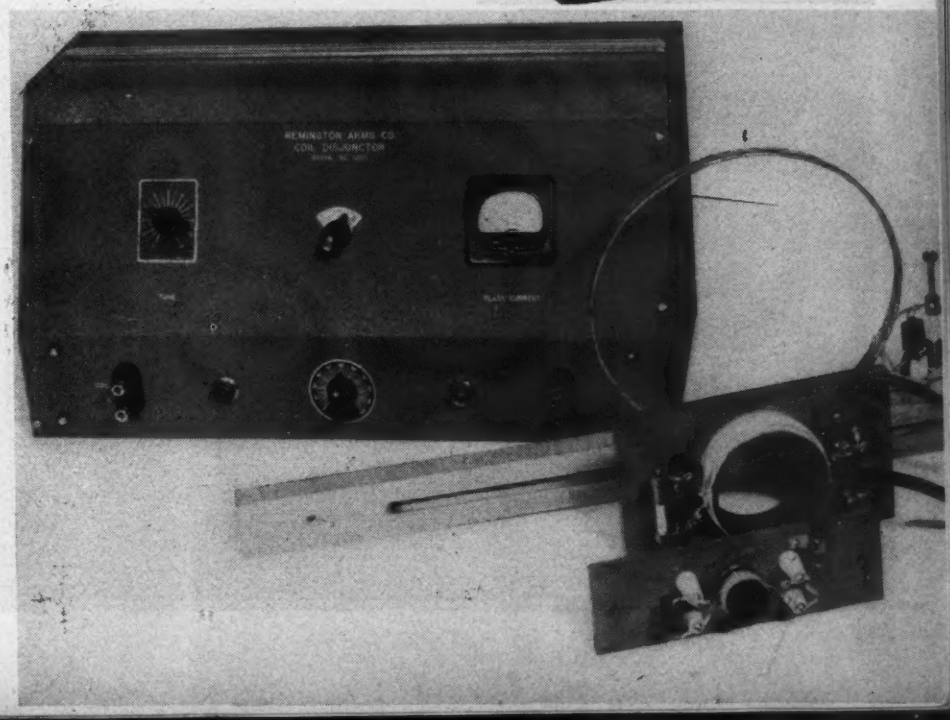
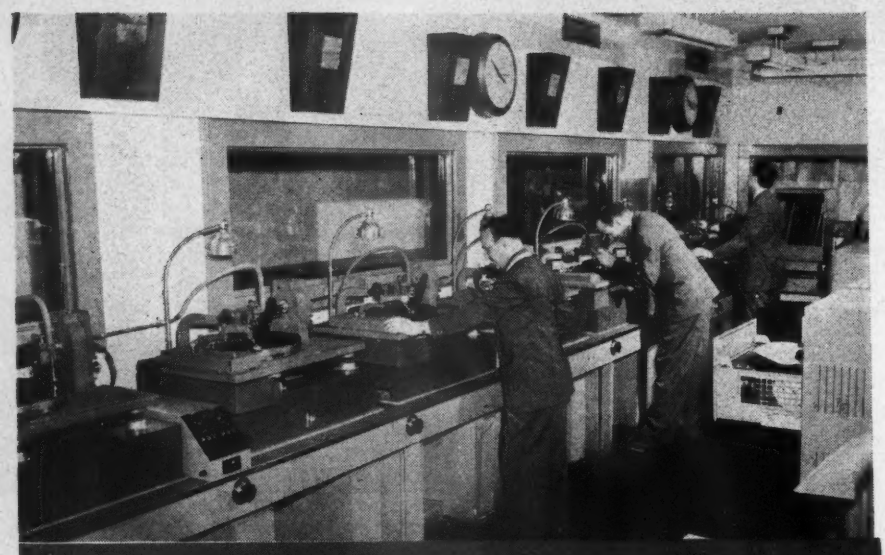


Fig. 3. Remington Arms Co. condenser type chronoscope is self-contained and portable. Intervals from 0.001 to 0.2 seconds are read directly on meter at right

Fig. 1. Coil disjunctor oscillator unit houses rectifier and first three tubes shown in schematic. Three typical coils shown range in size from 1-in. to 8-in.



OWI'S N



[illegible] side of the recording room showing seven of the nineteen lathes [illegible] cut masters from which pressings are made for foreign shipment

Opposite side of the recording room, containing thirteen racks of equipment, holds 40 Western Electric amplifiers of various types

Partial view of the master control console in the recording and transcription room. Turntables work in pairs with automatic switching

• The East coast central studio operation for OWI's Overseas Branch, now rapidly nearing completion, and at present largely in use, eventually will handle more originating programs simultaneously than all four of the major U.S. networks combined. With programs presented in every important language of the world in a continually changing pattern, the complexity of the schedule of operations might well try the experts of any domestic network. Add to that the control of studios for rehearsals, recordings and live programs with incidental music and sound effects and the problems become very real.

Sixteen studios

Stemming from an original two-studio installation, the operation when complete will include sixteen individual studios each with its own control room, a master control room with a 40 position to 40 position desk capable of feeding 20 of any 40 program sources to 40 outgoing channels simultaneously or individually; a central recording room for the production of masters for local use or from which pressings can be made for shipment abroad; and complete equipment for automatically recording every bit of every program broadcast by all the transmitters in the network.

With fourteen short-wave transmitters already under lease, OWI shortly will have 22 more stations, making a total of 36 that will raise "The Voice of America" to more than 2500 kw. The 22 new units are to include three transmitters of 200 kw capacity, two 100 kw, sixteen 50 kw and one 25 kw. This aggregation, it is planned, will permit a minimum standard of coverage of two frequencies in any particular area with eighteen simultaneous programs reaching the entire world during the best listening hours. Facilities of the East coast studio operation are equal to handling the entire group of transmitters.

Worldwide newscasting

Because 90 per cent of the time consumed by the voice at the OWI microphone is devoted to newscasting, the world's news must be gathered, sifted, analyzed, rewritten and prepared for presentation to an invisible but potent audience. To facilitate the work of news-gathering, America's great press services —the Associated Press, the United Press, and International News Ser-

NEW YORK STUDIOS

Equipment in east coast headquarters for handling special broadcasts routed worldwide by short wave

vice, plus the famed British press association, Reuters—have lent the full weight of their cooperation.

Hundreds of thousands of words of copy daily flow in an unending stream across the desks of the OWI news editors. The news comes in not alone from the wire services, but from the leased-wire facilities of the international carriers—Western Union and RCA; Postal Telegraph and Commercial Cables; Press Wireless and Mackay Radio; and the circuits of the United States Army Signal Corps.

Teletype is bloodstream

The teletype circuits are the bloodstream of OWI. There are some 25 teleprinters in one spacious room in the Washington headquarters, and the scene is duplicated in New York and San Francisco. Six of the machines are high-speed duplex printers, equipped both to send and receive simultaneously and to relay automatically.

Through a reperforator, a device which punches out the copy in transmission tape simultaneously as it is being received, the news is sent to the War Department in Washington's Pentagon building, where it proceeds on a point-to-point radioteletype circuit to Algiers. There, it sees the light of day in many an Army publication, including the soldiers' crack newspaper, "The Stars and Stripes."

Duplex circuits

Because the circuit is a duplex, Algiers transmits to the OWI a like volume of news and features daily. Much of the news from Algiers, key OWI signal point for North Africa, is written by ace American news correspondents, a portion of it destined for America's newspapers and magazines. The facilities of this link, furnished by the Army Signal Corps, are free to accredited news correspondents in the area now made historic by the defeat of the Afrika Korps.

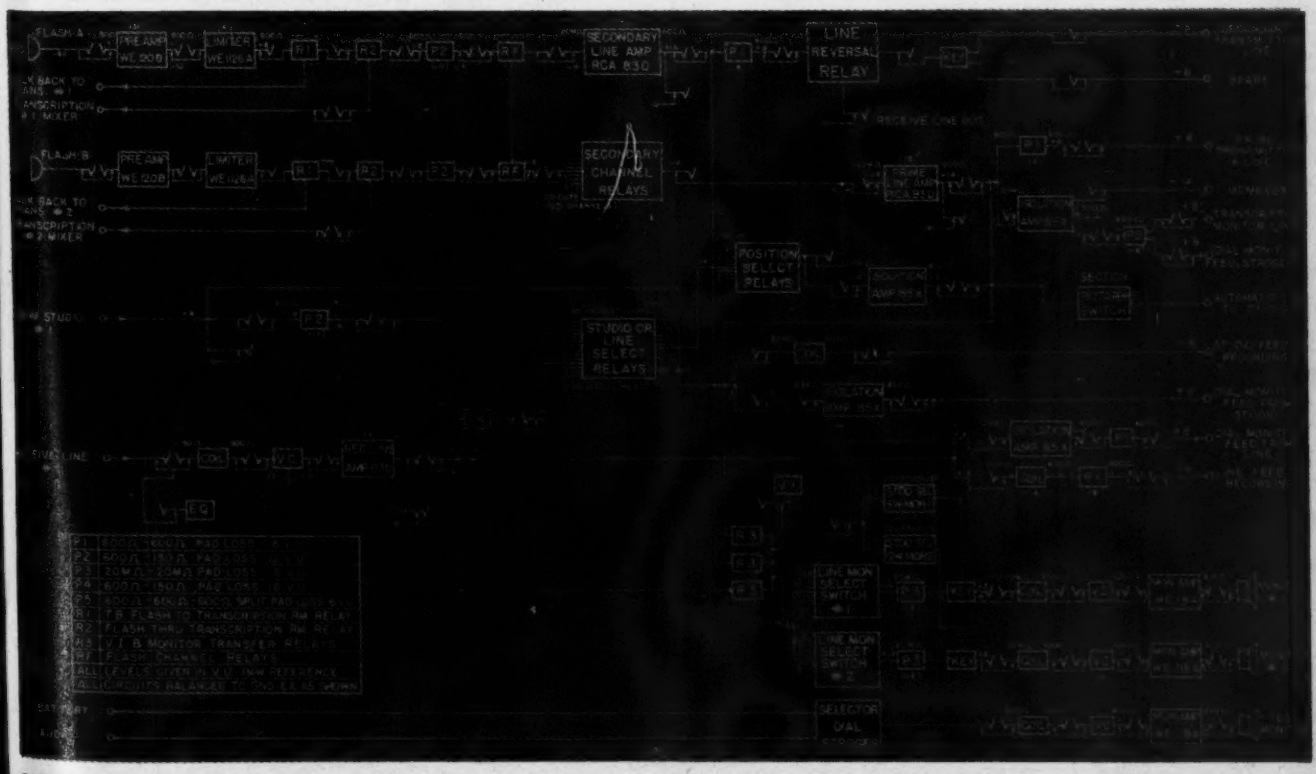
But Washington is only a relay point for the teletypes. New York is Operations. From OWI's New York Bureau, spot news is transmitted to every section of the globe except Latin America — and Latin America receives the news from the Office of the Coordinator of Inter-American Affairs through a direct link with the OWI wires.

The bulk of the transmission is beamed worldwide by blind-one-way-uncontrolled radioteletype broadcasts over the facilities of Press Wireless on a scheduled basis. The copy is either picked up or lost —but reports from the field and the more than 30 OWI international outposts show that better than 95 per cent of these transmissions are getting through. Because OWI is not anxious to spend the taxpayers' money wantonly, this method of transmission is used in the great majority of instances. This way, the cost breaks down to about two cents a word. Point-to-point, over the circuits of the international carriers, the cost would multiply 20-fold. But where something must go through, direct point-to-point facilities are used.

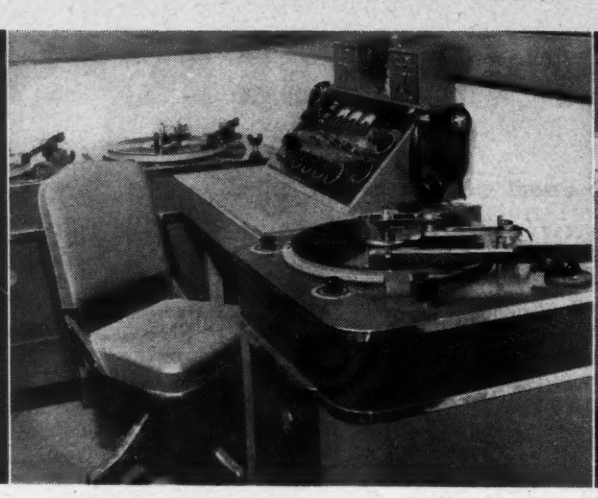
Establishing contacts

When OWI wants to set up a new circuit it consults Press Wireless. After an agreement upon the volume of news to be transmitted and the time of the transmission, Press Wireless is queried about an available frequency. The outpost receiving point is advised in advance about the tentative arrange-

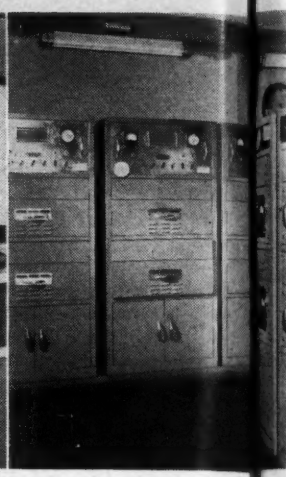
Block diagram of a single typical section of master control room in OWI New York studios



Part of patching equipment which occupies one side of master control room



Console in transcription room permits breaking any station for announcements



Part of bank of 20 which all outgoing

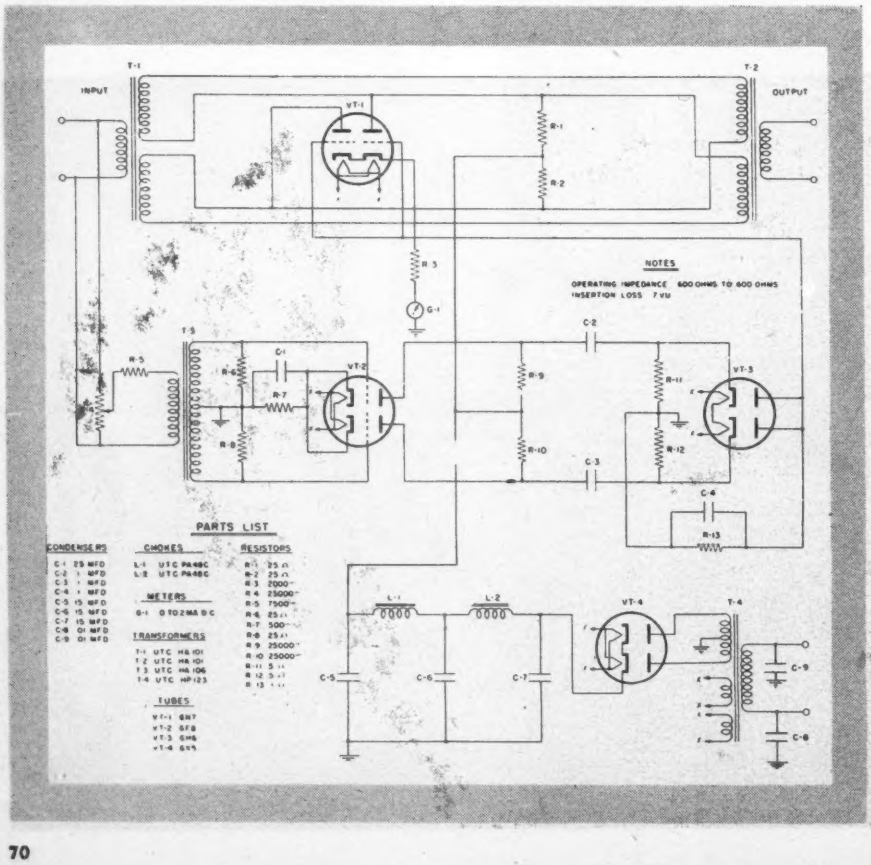
ment. Tests begin with a transmission speed, in most cases, of about 150 characters per minute; roughly 30 words. The test is conducted for a three-day period, during which time the outpost reports on the signal strength, clarity of transmission, suitability of frequency. Occasionally, unintentional "jamming" will necessitate changing the pre-selected frequency. But if the tests are successful, the agreed-upon frequency is used, and transmissions at regular times are scheduled. The latest such circuit to be so established is one to Madrid, Spain, which opened late in June.

And from New York, relayed from San Francisco and Washington to OWI's London Bureau, go coded cables and secret operational messages over private circuits and leased duplex wires. So secret are many of these messages, that they are "scrambled" as well as coded to make them unintelligible to any casual listener.

But because time is the essence of news, OWI's great teleprinter network has an interoffice subsidiary. The news, incoming and outgoing, which streams across the editors' desks, moves over the Basic News teleprinter interoffice network to 22 different language sections within the OWI organization, including the Coordinator's Office, and both the Columbia Broadcasting System and the National Broadcasting Co. Some 45,000 words a day are circulated in this manner to prepare for the broadcasts.

Broadcast operations over OWI's Bronze Network from New York fall into three classifications: Studio Operations, Traffic, and Engineering. Under Studio Operations is the Program department, which checks and prepares proposed schedules for broadcast and submits its report to the Traffic department. Traffic indicates after a check with Master Control which lines of transmission are available, and informs the Program department, which then makes up its final operating schedule.

Special volume compressor, designed and built in the OWI shop

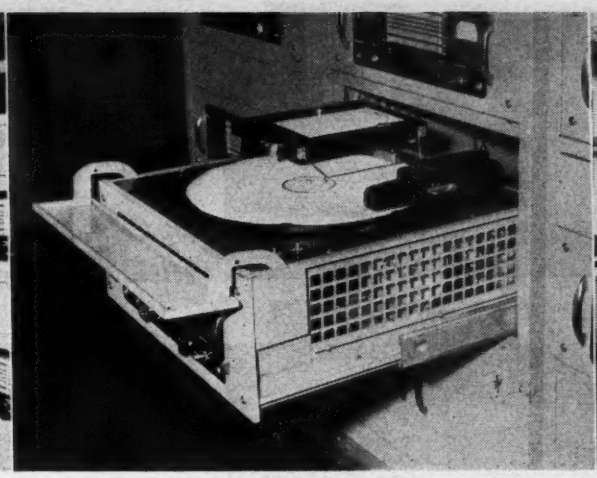


7,686 broadcasts in June

The broadcasting studios in New York are on the air over 2,500 hours per month. In June, 7,686 programs were originated, 380 of which were transmitted over the point-to-point facilities of the American Telephone & Telegraph Co. direct to the British Broadcasting Co. in London, where they were medium-waved to the Continent. Some 261 short wave programs were originated by NBC and CBS, the majority of which were special service shows for troops. This was the month before the Sicilian invasion, when the schedule was increased.

Because OWI's transmission load is heavy, new advances have been made in the broadcast Master Control to meet the unusual demands —advances which will have a peacetime importance. Frequently, Master Control must carry eight programs simultaneously, and to meet this load it has been wired for pre-setting on broadcast patterns. One such design is OWI's Pattern

Memovox machines with programs are recorded



Memovox machines function in pairs with automatic signal to operator to start alternate

Part of OWI studio equipment is an extensive service shop for building special equipment

"A," a 24-hour series of broadcasts to Continental Europe in French, German and Italian, with a complete show on the air-every 15 minutes. Pattern "B," which is beamed to North Africa and Southern Europe, takes the air around-the-clock in English, Spanish, French and Portuguese. In addition, the programs are recorded and sent to the outposts for rebroadcast.

Control facilities

The Master Control room, soon to be completed, holds some 20 racks of equipment, not to mention a specially designed PBX telephone switchboard for intercommunication. These racks hold 56 RCA 83D channel amplifiers; 76 RCA 85X isolation amplifiers; 3 WE 118 monitor amplifiers; 3 RCA 64B speakers; and 3 WE 1126 compressors. All told there are 8000 jacks and 1600 indicating lamps. Throughout the installation there are more than 1000 new type WE relays which have 20 springs on a side.

In addition to the three standard WE compressors, a fourth compressor, designed and built in OWI's own extensive shops, also is in use. It is of the balanced bridge type with no tubes in the input circuit. At 10 db compression, distortion is but 1.4 per cent at 400 cycles; at 5 db compression, distortion is .4 per cent. Insertion loss is 5 db.

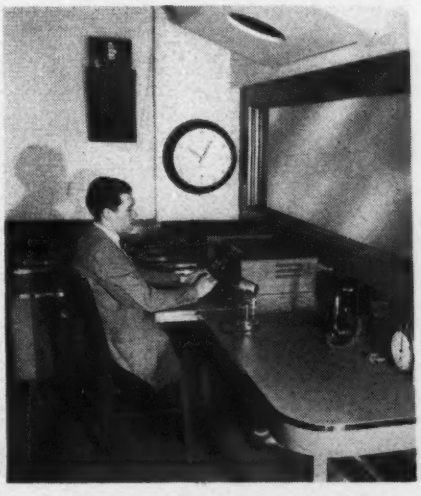
The transcription room, adjacent to master control, holds three RCA turntables so arranged that any or all of them can be used individually or simultaneously. These tables are locked in exact position for cuing and are electrically started automatically without wow or drag. An adjacent small announce room contains a switchboard with which the announcer can make station breaks directly on any of 20 transmitters individually, or on all of them simultaneously in case of necessity.

In control rooms adjacent to each of the 16 studios, the principal piece of equipment is a WE 23C consolette, though in each case these have been very considerably redesigned and rewired to fit them to special requirements. For example, they now have six channels instead of the usual four. Provision has been made for a split talkback method whereby it is possible for the announcer to talk back to the studio when the turntable is on. Each room is equipped with a pair of RCA turntables.

14 recording lathes

The recording room, which is now practically complete, contains 13 racks of equipment including 14 WE 105 amplifiers, 18 WE 118 amplifiers and 14 WE 1087A or 1087B amplifiers. Equipment for recordings includes 14 RCA 73A lathes. These are used as occasion may require either for making disks for re-broadcast or for making masters from which pressings are made for shipment abroad.

Typical small announce room adjacent to each studio

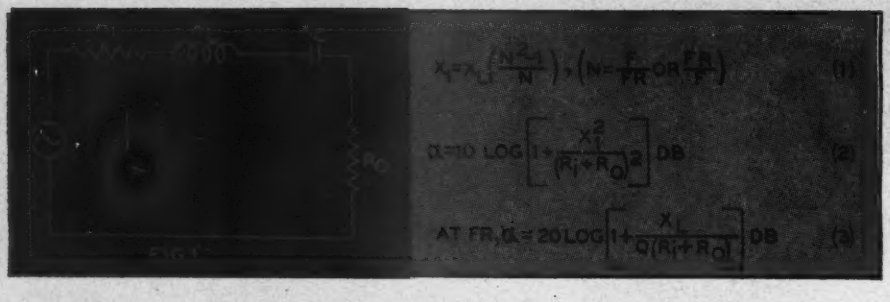


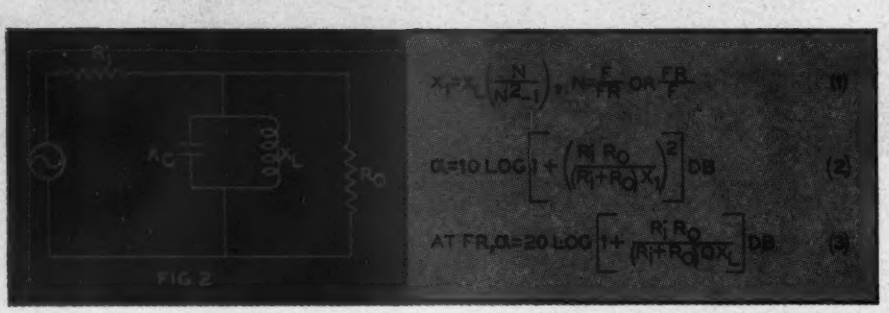
These lathes have been mounted in an unusually solid fashion. Heavy Lord mountings are fastened to an oak plank two inches thick which in turn is bolted to concrete piers which weigh 350 pounds each. The piers are mounted on Keldur which rests on the concrete floor. Prior to the installation of the equipment a careful survey was made to determine the extent of vibration that might exist and it was found to be practically nil. Nevertheless, these elaborate precautions were taken to see that the turntables were as perfectly isolated as possible. Cuttings are drawn by vacuum pump through polished stainless steel pipes into a separate room where automatic equipment washes them and deposits them in a sealed container for twice-a-week disposal.

Program recording

The turntables are arranged to function in pairs. Controls permit the tables to be used either singly or simultaneously, or they can be switched to operate consecutively with the second machine coming on automatically to pick up the program when the disk on the first machine is completely full. A slight overlap insures continuity.

Also in the recording room there are 20 Memovox machines with which every program is automatically put on Dow or Eastman thin plastic disks for record purposes. Here, too, the machines operate in pairs, with the program automatically shifted to the second machine when the disk on the first has been filled up. When this occurs a relay operated bell signals the operator to reload the machine that has become idle.


$X_1=X_L\left(\frac{N^2-1}{N}\right)$, $\left(N=\frac{F}{FR}\text{ OR }\frac{FR}{F}\right)$ (1)
$\alpha=10\ LOG\left[1+\frac{X_1^2}{(R_i+R_o)^2}\right]$ DB (2)
AT FR, $\alpha=20\ LOG\left[1+\frac{X_L}{Q(R_i+R_o)}\right]$ DB (3)


$X_1=X_L\left(\frac{N}{N^2-1}\right)$, $N=\frac{F}{FR}$ OR $\frac{FR}{F}$ (1)
$\alpha=10\ LOG\left[1+\left(\frac{R_i R_o}{(R_i+R_o)X_1}\right)^2\right]$ DB (2)
AT FR, $\alpha=20\ LOG\left[1+\frac{R_i R_o}{(R_i+R_o)X_L}\right]$ DB (3)

Designing

by **HARRY HOLUBOW**
Thordarson Electric Mfg. Co., Chicago

Semi-graphical computing filter design with pre-

shown in Figs. 1 to 4 inclusive. Figs. 1 and 2 give a band-pass effect, and if the input and output impedances are equal, either one may be used to give the same response characteristic. The selection of the circuit will depend on other conditions: from Fig. 1 it is apparent that if R_o is ∞ this configuration cannot be used, and on the other hand, if $R_i = 0$, Fig. 2 cannot be

• Audio and somewhat higher frequencies are being used extensively for signaling and control purposes in the electronic industry. Many of these applications cannot be revealed at the present time, but it is likely that their use will be extensive after the war. Unlike the transmission of speech and music, the frequency band required usually is narrow so that means for excluding unwanted frequencies is desirable.

The computations used in this article are based upon the assumption that a simple resonant circuit is either resistive or reactive. While it is true that the resonant circuit may be considered resistive at resonance, it is not purely reactive outside of the resonant frequency because of the inherent loss in the reactors. This effect, however, is of importance only near the resonant frequency, and may be calculated to an approximation.

Types of circuits

In many applications where a frequency-discriminant circuit is desired, the necessary results may be obtained by means of a simple resonant circuit, series or parallel, provided that the proper LC values are selected. Although a band pass or band elimination filter will, in general, give a sharper discrimination than a single tuned element, a filter usually requires several high Q chokes which generally are expensive. Furthermore, a filter is usually designed to work between equal impedances unless impedance matching is provided, while a single tuned element may be designed regardless of impedance.

The series or parallel circuit may be used as a single element as

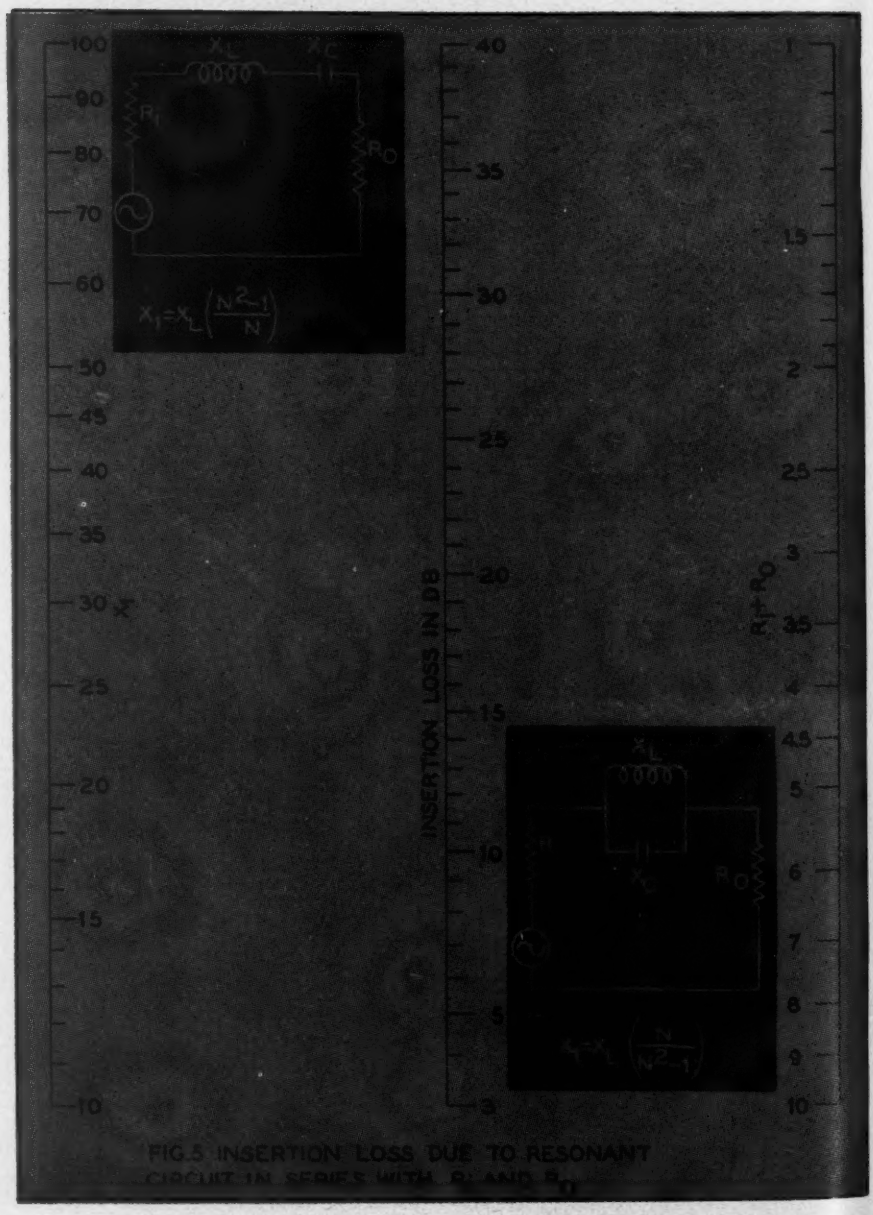
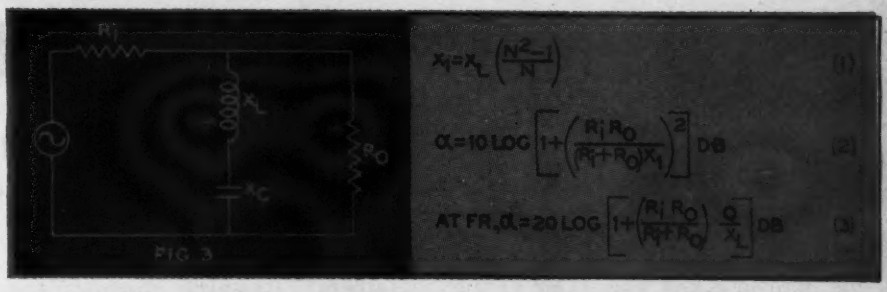
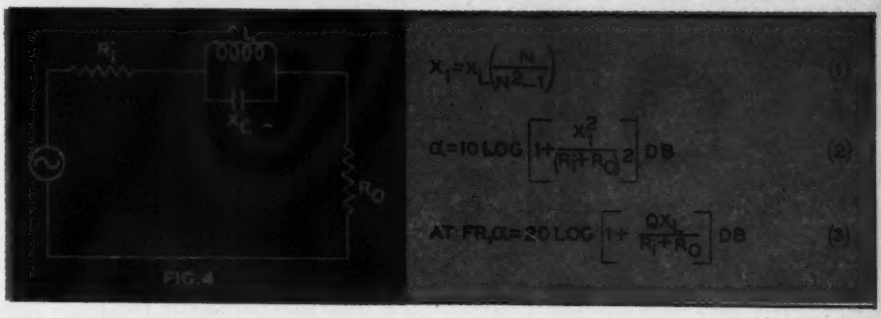


FIG. 5 INSERTION LOSS DUE TO RESONANT CIRCUIT IN SERIES WITH R_i AND R_o

AF Filters

method for low frequency determined characteristics





method for low frequency determined characteristics

used. While these are limiting conditions, it is apparent that if R_i is much smaller than R_o, Fig. 1 is the one to use, while if R_o is very large Fig. 2 may be of advantage.

Fig. 3 and Fig. 4 give a band-elimination effect, and here also the choice of either the series or parallel circuit will depend upon the input and output resistances, and upon a few other conditions.

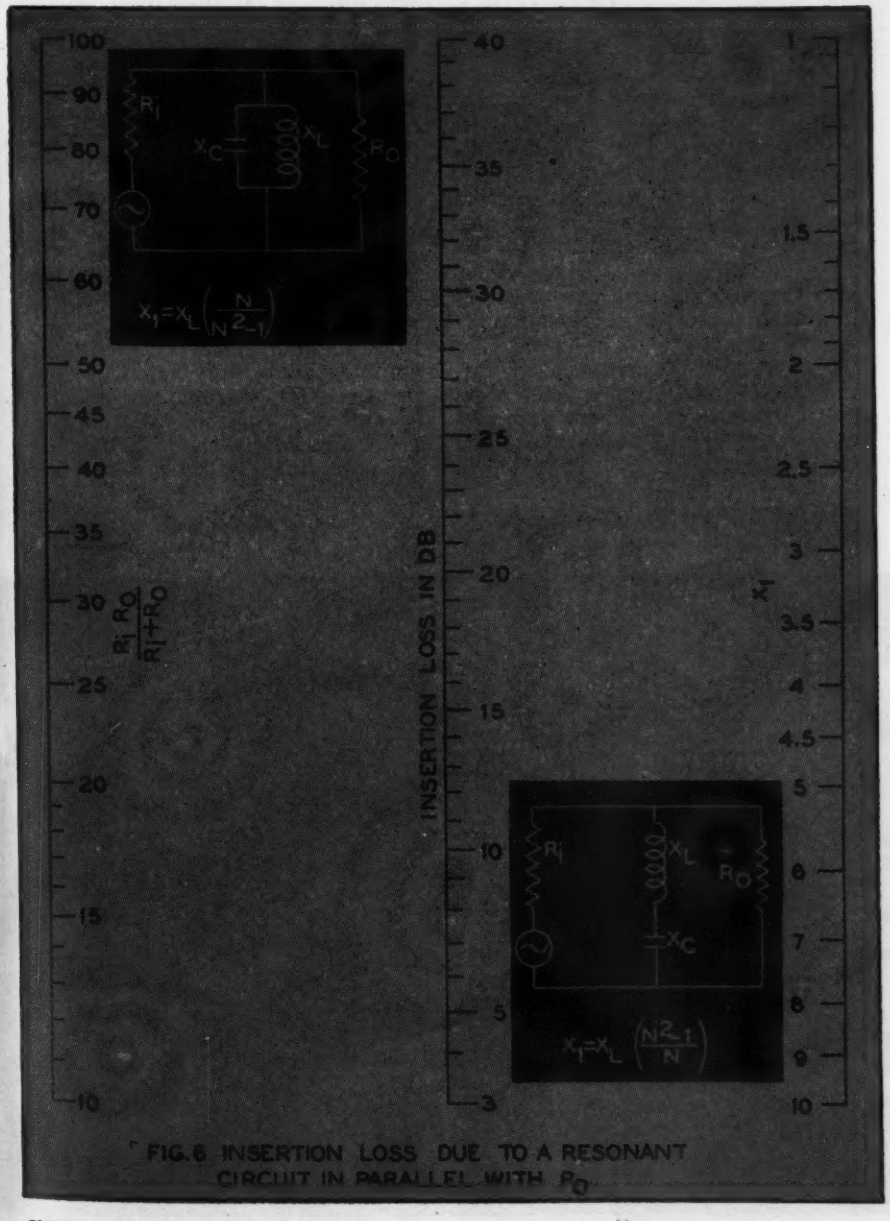


FIG.6 INSERTION LOSS DUE TO A RESONANT CIRCUIT IN PARALLEL WITH R_O

The reactance of a series LC circuit may be written as $2\pi fL - \frac{1}{2\pi fc}$. This reactance is capacitative at frequencies below resonance and inductive at frequencies above resonance. At the resonant frequency the circuit becomes resistive; the value of the resistance depends upon the Q of the coil and the capacitor. If we call the impedance of the reactor or capacitor at the resonant frequency X_L (at resonance $X_L = X_C$), at any other frequency F, the impedance of the reactor, may be expressed as NX_L where $N = \frac{F}{F_r}$. The total reactance of the series LC at the frequency F then becomes $X_1 = NX_L - \frac{X_L}{N} = X_L\left(\frac{N^2-1}{N}\right)$. Changing the value of N to $\frac{1}{N}$ does not change the absolute value of this expression, except the sign. We may therefore call N either $\frac{F}{F_r}$ or $\frac{F_r}{F}$ so that for convenience of computation N is greater than unity.

The series LC circuit, outside of the resonant frequency, is therefore quickly reduced to a positive or negative reactance in series or parallel with R_o. In the same manner it may be shown that the equivalent reactance of a parallel LC circuit at any frequency (outside of the resonant frequency) is $X_1 = X_L\frac{N}{N^2-1}$ where X_L, X_1 and N have the same meaning as for the series resonant circuit. Therefore the parallel resonant circuit is also re-

(*Continued on page* 188)

POLYSTYRENE REPLICAS

Electron microscopy of metal surface structures improved by Dow's polystyrene-silica surface-molding technic

• Plastic materials are now assisting man in many ways. One of the newest uses for polystyrene is as a plastic "window." Through the use of transparent replicas of surfaces in electron microscopy, many facts of importance to metallurgy, electronics, physics, and chemistry are revealed.

The exceptional properties of polystyrene moldings make this material suitable for recording faithfully the minute surface structures of metals for study under the electron microscope. A precision molding may be made with such accuracy that details as small as 0.0000005-in. may be reproduced. What is more important, correct dimensions are preserved even after chemical removal of the metal in acids or alkalies.

Transparencies essential

Since the specimen must be placed in the electron stream, the study of metallic samples must be done indirectly, as the metal itself is opaque to an electron stream. Several methods of producing such replicas have appeared in literature, chief among which are the natural oxide films of Mahl[2], the direct Formvar films of Schaefer and Harker[3], and the silver-collodion process of Zworykin and Ramberg[4]. Research chemists and physicists working in the laboratories of the Dow Chemical Co. have developed a new replica technic which has been successfully applied to a number of different surfaces. It is a two-step process using polystyrene as the first replica, and an evaporated silica film as the second replica. The second replica is the one viewed in the electron microscope but is not possible without the development of the first thermoplastic replica.

Powder molding technic

The method of formation of these replicas is not complicated[5, 6]. It consists of making a plastic impression against the material to be viewed. After the surface of the material to be studied is polished and etched through satisfactory technics, polystyrene is molded against it. Commercial, low-viscosity molding powder in the form of granules is suitable. An ordinary mounting press will serve for making the molding.

The specimen, mounted or unmounted, is placed in the press with sufficient polystyrene granules on the surface to give a final molding of a thickness of about ½ in. The mold is then heated to 130 deg. C. before applying any pressure, since premature application of pressure will force the hard granules against the surface and result in possible specimen deformation. This is particularly true of the soft metals.

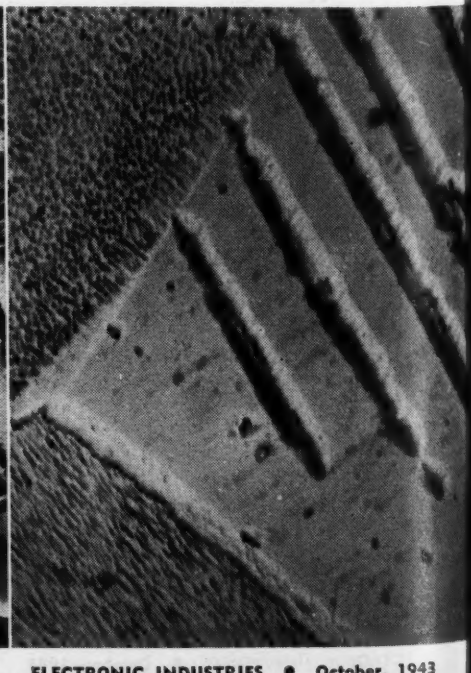
A pressure of 2,000 to 5,000 lb. can be applied and the temperature raised to 160 deg. C. The mold is then allowed to cool, maintaining constant pressure until the temperature has dropped to well below 80 deg. C. This precaution prevents formation of bubbles in the molding. If decreased molding pressures are desirable, they can be obtained through the use of molding temperatures up to as high as 200 deg. C.

Dissolving metal "die"

The removal of the metal from the polystyrene can be accomplished either by mechanically jarring it loose or, preferably, dissolving the metal in an acid. Polystyrene is extremely resistant to most acids and is unaffected by the common acids that would normally be used for dissolving the metal specimen. Any of the mineral acids, except H_2SO_4, in a moderate concentration (1:3), can safely be

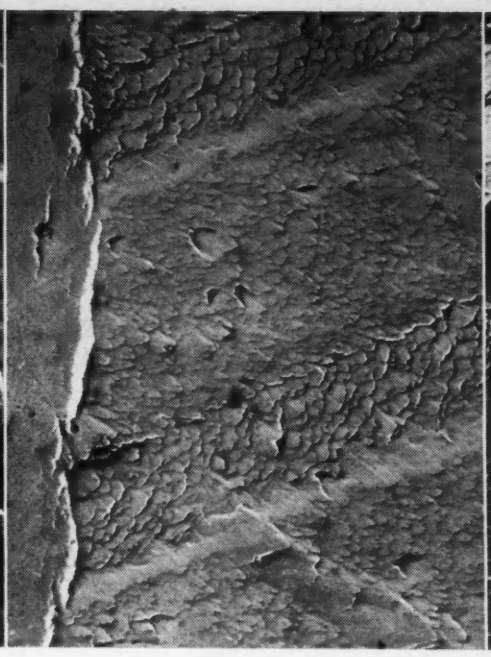
Highly polished steel surface

Slip bands in a calcite crystal viewed through polystyrene-silica technic

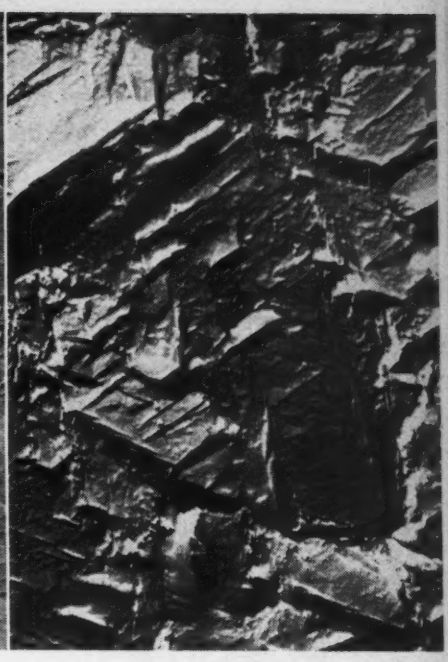


Etched stainless steel

Etched, pure magnesium



Etched copper viewed through polystyrene - silica technic



Fractured magnesium surface

used without damage to the polystyrene. Acetic acid and caustic may be used as well.

When the metal is dissolved, the polystyrene surface is washed with dilute acid followed by a swift stream of double distilled water and then dried in clean air. It should then be examined in a light microscope for any dirt or salt that might remain on the surface.

The second step of the replica preparation is the silica evaporation or sublimation. Actually, the silica is condensed on the styrene replica surface (in vacuum) from a conical tungsten filament. Pure quartz in the form of small splinters is placed in this conical filament and the styrene molding mounted vertically above it at a distance of 6 to 8 cms.

Sublimation of quartz film

Rapid evaporation of the quartz (30 seconds) is then brought about without causing the temperature of the styrene surface to rise above 50 deg. C. The amount of quartz to be evaporated will depend on the roughness of the surface. The silica, as it condenses on the polystyrene surface, appears to be very fluid. It accordingly fills all of the depressions and then sets thermally to a solid material. It tends to fill all depressions of size greater than one μ across.

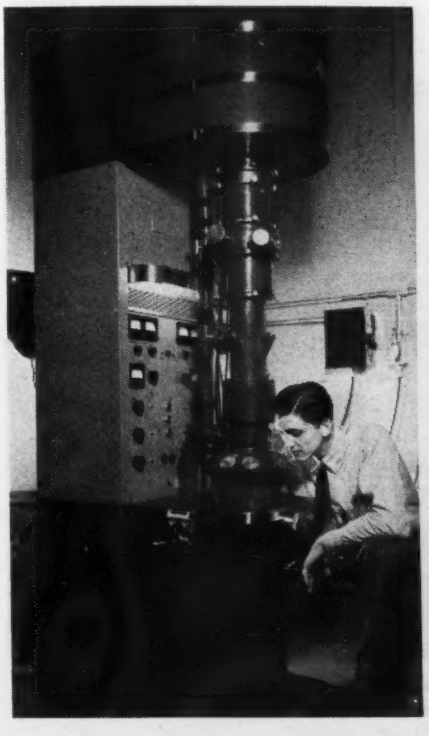
The sample, after being cut into squares, should be placed in ethylene bromide with the replica side up. The silica squares will be released from the styrene in some five minutes and can be easily seen in the liquid. The silica films are removed from the first solvent and placed in a dish of fresh solvent to remove any additional styrene. They are picked up from here on the usual specimen screen and are ready for the microscope.

Advantages of new process

Of course, it is important that all details of the original sample be accurately reproduced throughout the process. Were it not for the detail with which polystyrene can be molded, this would not be possible. Actually, this two-step process utilizing polystyrene offers important advantages in the electron microscope:

1. High resolution and excellent contrast. A resolution of 40 Angstrom units is readily obtained in the silica reproduction.
2. The method is independent of the surface properties (surface tension, hydrophilic films, etc.) of the material to be studied and depends, rather, upon externally applied pressure to produce the first replica. Hence, it finds application to a wide range of surfaces, such as nearly all metals, glasses, etc. It is well adapted to metallographic studies.

The electron microscope as used in the research laboratory of the Dow Chemical Co.



Why polystyrene?

Polystyrene has been found to be best suited to the process due to its chemical inactivity, dimensional stability, and moldability. The low water absorption of molded styrene makes the first replica capable of being preserved for a considerable time before the final film of silica is prepared.

[1]V. K. Zworykin, J. Hillier, and R. L. Snyder, "A.S.T.M. Bulletin," No. 117, pp. 15-23 (1942).
[2]H. Mahl, "Zeits f. tech. Physik," Vol. 22, p. 93 (1941).
[3]V. J. Schaefer and D. Harker, "Journal of Applied Physics," Vol. 13, p. 427 (1942).
[4]V. K. Zworykin and E. G. Ramberg, "Journal of Applied Physics," Vol. 12, p. 692 (1941).
[5]R. D. Heidenreich and V. G. Peck, "Electron Microscope Study of Surface Structure," "The Physical Review," Vol. 62, Nos. 5 and 6, pp. 292-293 (Sept. 1 and 15, 1942).
[6]R. D. Heidenreich and V. G. Peck, "Fine Structure of Metallic Surfaces with the Electron Microscope," "Journal of Applied Physics," Vol. 14, No. 1, pp. 23-29 (January, 1943).

Positive Grid Oscillators

by DR. LUMIR F. DYTRT

Operation characteristics of decelerating-field oscillators with graphical performance data on frequency and voltage relations

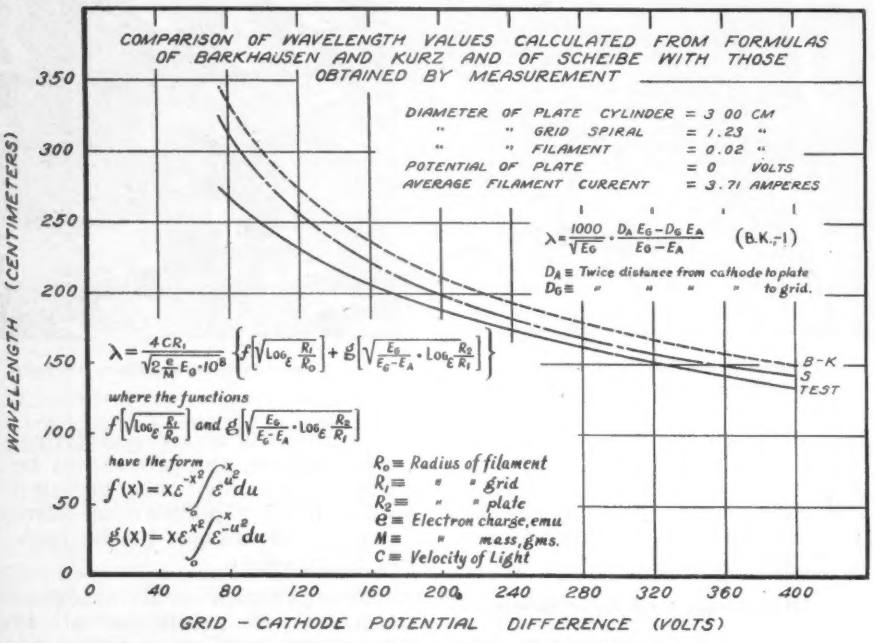

COMPARISON OF WAVELENGTH VALUES CALCULATED FROM FORMULAS OF BARKHAUSEN AND KURZ AND OF SCHEIBE WITH THOSE OBTAINED BY MEASUREMENT
DIAMETER OF PLATE CYLINDER = 3.00 CM
" " GRID SPIRAL = 1.23 "
" " FILAMENT = 0.02 "
POTENTIAL OF PLATE = 0 VOLTS
AVERAGE FILAMENT CURRENT = 3.71 AMPERES
B-K
S
TEST
where the functions
have the form
R_o ≡ Radius of filament
R_1 ≡ " " grid
R_2 ≡ " " plate
e ≡ Electron charge, emu
M ≡ " mass, gms.
C ≡ Velocity of Light
WAVELENGTH (CENTIMETERS)
GRID - CATHODE POTENTIAL DIFFERENCE (VOLTS)

Fig. 1. Wavelength and positive grid-cathode voltage relations as computed and observed. Curve S is plot of formula at lower left

● Though no longer occupying a place of prominence among ultra-high frequency generating means, the positive grid triode oscillator, because of its simplicity and its requirement of generally obtainable parts, still may be found by many as the only centimeter wave generator currently available to them for fulfilling their various needs. So, too, a review covering salient details relating to the oscillator may be found timely. According to Barkhausen and Kurz[1], discoverers of the positive grid triode oscillator they chanced upon their discovery while attempting to determine the degree of vacuum in a triode having concentrically-arranged, cylindrical electrodes. For their purpose they had thus connected the tube electrodes in an ionization gage circuit, i.e., a positive potential was applied to the grid and a small negative potential to the plate. Series connected, dc instruments were then arranged to give indications of electron flow to the grid and positive ion collection at the plate. In these circumstances, however, it was found that the plate instrument gave an indication that was the reverse of that expected. Moreover, increases in the negative potential of the plate failed to make the instrument show a current reversal.

Realizing that electrons, the evident basis of the plate current, could not traverse the negative field's length presumed to exist in their tube unless such electrons were externally influenced, Barkhausen and Kurz looked into the possibility of high-frequency voltages being superimposed upon the supply potentials. Their search, made with a detector and galvanometer that were connected to windings placed closely about the tube, yielded results, and so confirmed the experimenters' surmise.

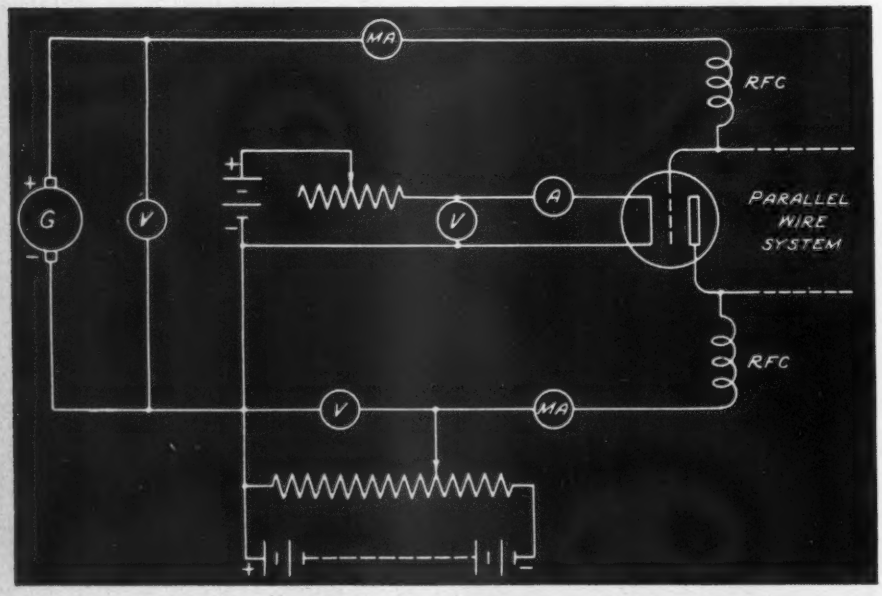


Fig. 2. Test circuit of positive-grid oscillator using transmission line tank. Line should be approximately ½ wavelength

Early experimenters

Barkhausen, Kurz and Scheibe[2] derived formulas for the wavelength to be expected in positive grid tubes. Some idea of the disparity existing between experimentally determined wavelengths and those computed may be gathered from the equations described and plotted in Fig. 1. There the curve designated by "B-K" was determined by wavelength values calculated from the equation BK-1 above it and curve S by the wavelength relation at its left.

Other experimentally-determined wavelength characteristics of a positive grid triode oscillator appear in Figs. 4, 5, 6, and 7, while a type of circuit for one is shown in Fig. 2.

After a concurrent study of possible electronic movements in an oscillator tube Gill and Morrell[3] evolved a theory which though adequate to account for the oscillations developed yet lacked the cogent qualities essential to its gaining general acceptance. Creating most skepticism of the theory perhaps was the indicated premise that oscillations had their origin in the actions of electrons confined mainly to the grid-plate space of a tube.

Briefly, the work of Gill and Morrell demonstrated:

1. The frequency of oscillations produced by a positive grid triode oscillator is, within varying limits, dependent upon the constants of the connected circuit.

2. The alternating potential between grid and plate electrodes, by increasing the kinetic energy of some electrons and decreasing that of others, acts to sort them out so an organized movement results.

3. The rate at which work is done by electrons returning to the grid, for certain frequencies and applied potentials, may be sufficient to maintain an oscillatory state.

Later an important extension or generalization of the theory just outlined was made by Llewellyn[4]. Instead of restricting attention to events in a single portion of an oscillator tube, as did Gill and Morrell, he made his inquiry embrace the whole inter-electrode space. He, too, studied the working capabilities of electrons that emerge from the cathode at different instants along an alternating voltage cycle, but unlike Gill and Morrell he gave consideration to the charges from the instant they left the cathode.

To simplify his analysis, Llewellyn assumed as acting between grid and plate, and, hence, also between grid and cathode, an alternating voltage whose period is approximately equal to the time of travel of an electron from cathode to plate. The effect of such a voltage on two separate electrons (one leaving the cathode when the voltage is starting its rise to create a maximum attractive field toward the grid, and the second electron leaving the cathode when the voltage is reversing and thereafter acts to produce a subnormal field) are readily followed.

The first electron, in moving from cathode to grid, would experience an attractive effort by the component of the electric field produced by this alternating voltage. Since this voltage completes an alternation and reverses its direction shortly after the electron passes the grid, a depression below average of the positive value of grid potential follows. Thenceforth there is an inadequate opposition to the flight of the first electron. Accordingly, it is to be expected that this electron, in the absence of an applied, repellent potential on the plate, would arrive there.

From a work standpoint one perceives that this particular electron not only does no work toward maintaining the oscillations but, contrariwise, acts to suppress them by acquiring kinetic energy at the expense of the oscillatory field.

Emergence of the second electron a half-cycle after the first means that movement of the former from cathode to grid would take place while the alternating voltage is setting up a field in the cathode-grid space which opposes the motion of the second electron. Impelling the second electron on toward the grid, therefore, would now be a field that, for analytical purposes, may be regarded as the difference between that due to the steady, applied potential on the grid and that resulting from the alternating voltage.

Since this resultant field obviously would have to be weaker than the corresponding one that acts on the first electron, the second would

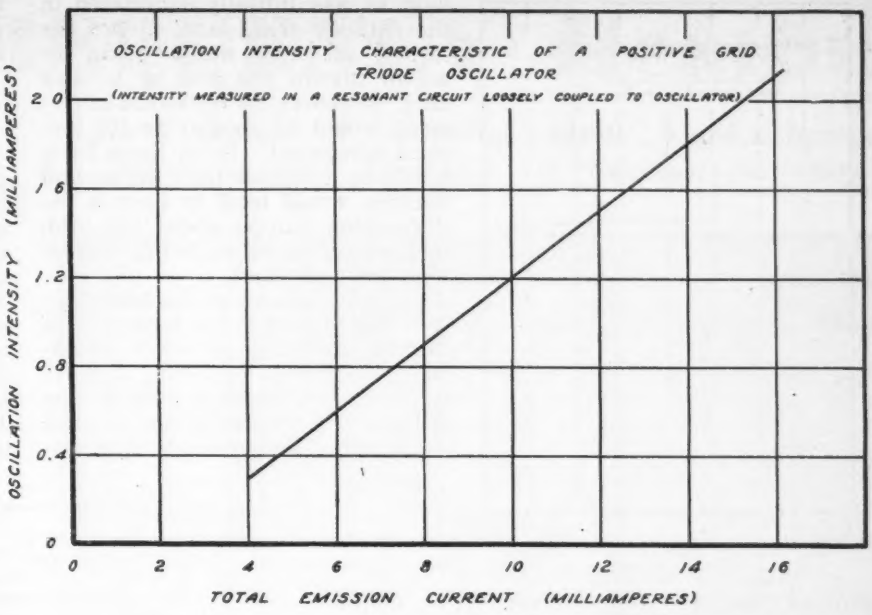


Fig. 3. Strength of oscillations is linear function of total cathode current over range observed

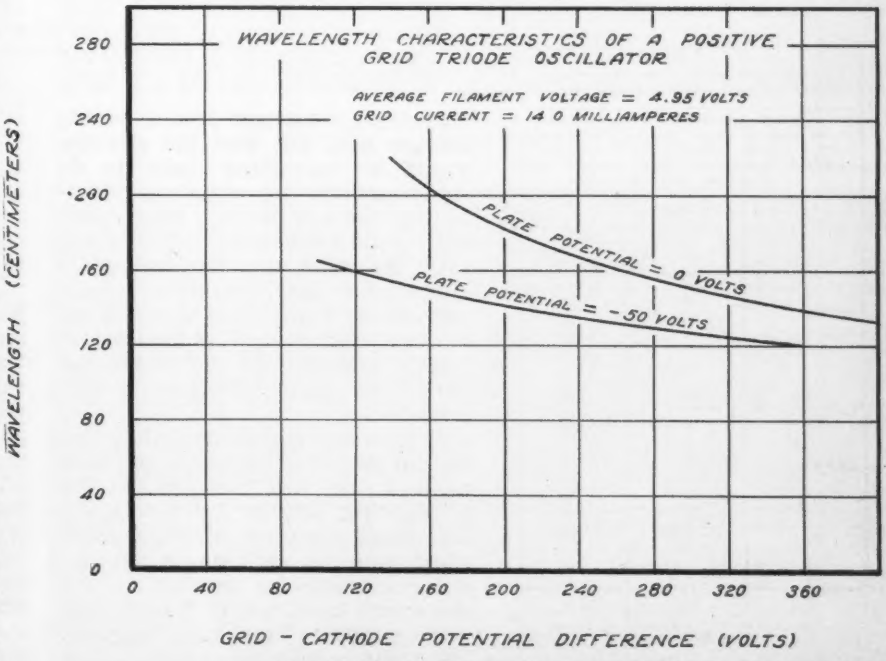


Fig. 4. Higher frequencies are reached when larger negative plate voltages and positive grid voltages are applied

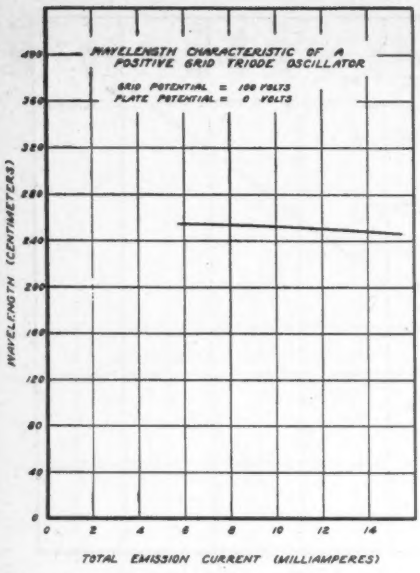

WAVELENGTH CHARACTERISTIC OF A POSITIVE GRID TRIODE OSCILLATOR
GRID POTENTIAL = 100 VOLTS
PLATE POTENTIAL = 0 VOLTS
WAVELENGTH (CENTIMETERS)
TOTAL EMISSION CURRENT (MILLIAMPERES)

Fig. 5. Frequency is varied only slightly by change in cathode current

travel more slowly and, consequently, would still be approaching the grid when the alternating voltage completed the alternation under consideration. Following its reversal, the alternating voltage would cooperate with the steady grid potential to establish in the grid-plate region a strong, retarding field for electrons moving outward beyond the grid. Upon entering this field then the second electron would be rapidly decelerated in its flight and brought to rest some distance before the plate. At about that time the alternating voltage would complete one cycle.

On its next reversal this voltage would function to produce in the plate-grid space the same form of field as was initially considered in the cathode-grid space. Hence the second electron would again be drawn toward the grid by a weak field; moreover, its backward movement would be similar to its forward movement. From these facts it will be apparent that the second electron would tend to have a reciprocating motion about the grid, each swing, however, being shorter than the preceding.

If, as in the case of the first electron, the motion of the second were studied now from a work standpoint, one would note that in moving over the greater part of the cathode-grid distance, the second electron would acquire kinetic energy from the preponderant, steady voltage field but that the electron would be compelled there to do work against the opposing, alternating voltage field. More work still would be done by this electron after its entry into the grid-plate space for by that time the alternating voltage would have made its reversal and so caused its field to act jointly with that of the steady potential to oppose motion by the electron.

It thus becomes evident that this second electron is made to do work against the field set up by the alternating voltage for practically the whole distance of travel outward from the cathode. A like deduction would be reached if the movement back toward the cathode were similarly analyzed. Accordingly, the conclusion is drawn that the second electron acts to maintain oscillations by doing more work on the oscillatory field than is done by it on the first electron.

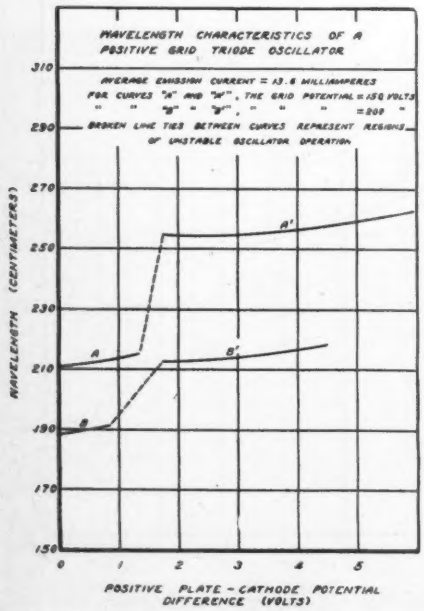

WAVELENGTH CHARACTERISTICS OF A POSITIVE GRID TRIODE OSCILLATOR
AVERAGE EMISSION CURRENT = 13.6 MILLIAMPERES
BROKEN LINE TIES BETWEEN CURVES REPRESENT REGIONS OF UNSTABLE OSCILLATOR OPERATION
A
A'
B
B'
WAVELENGTH (CENTIMETERS)
POSITIVE PLATE - CATHODE POTENTIAL DIFFERENCE (VOLTS)

Fig. 6. Effect of positive plate voltage on frequency of oscillation

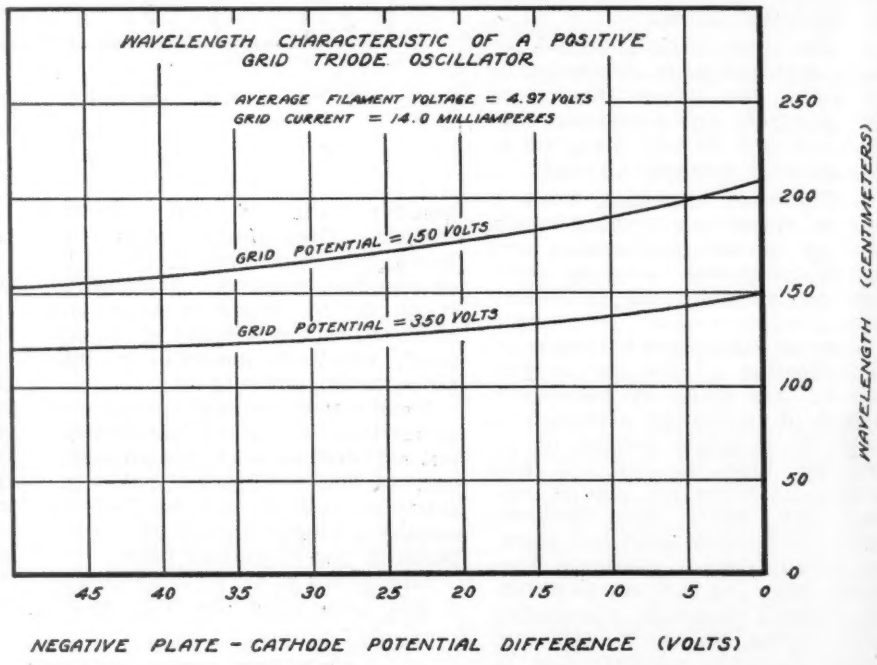

WAVELENGTH CHARACTERISTIC OF A POSITIVE GRID TRIODE OSCILLATOR
AVERAGE FILAMENT VOLTAGE = 4.97 VOLTS
GRID CURRENT = 14.0 MILLIAMPERES
GRID POTENTIAL = 150 VOLTS
GRID POTENTIAL = 350 VOLTS
WAVELENGTH (CENTIMETERS)
NEGATIVE PLATE - CATHODE POTENTIAL DIFFERENCE (VOLTS)

Fig. 7. Frequency of positive-grid oscillator is varied to greater extent by grid voltage than by plate voltage

Performance factors

By means of the theory just given it is possible to make certain inferences as to the performance of a positive grid oscillator. Its output power, for example, would be presumed small. Likewise it would be expected to have a low efficiency. Implied also by the theory is that the intensity of oscillations depends upon the number of electrons drawn away from the cathode. That such is indeed the case may be seen from Fig. 3. There the oscillation intensity is plotted against the total emission current (that is, against the arithmetic sum of grid and plate currents) and it is evident that for the range of values considered intensity and emission are linearly related.

Another factor having a pronounced effect on oscillation strength is the circuit connected to the grid and plate of an oscillator tube. Together with the tube electrodes and leads the external circuit forms a system having one or more natural periods that permit of the system to exhibit marked resonant characteristics when properly excited. Ordinarily these resonant effects are brought into play by simple adjustments of grid and plate potentials.

So far no indication has been given that a positive grid oscillator

(*Continued on page* 180)

HIGH FREQUENCY Heating

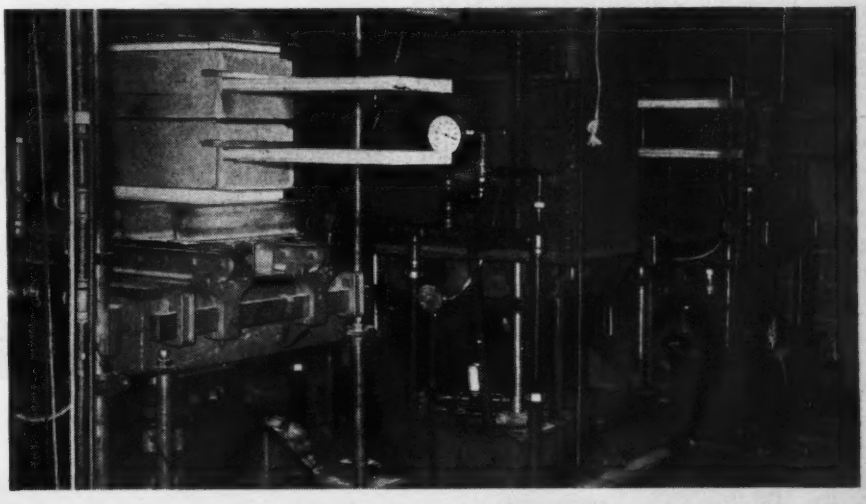
Uniform gluing of propeller blade blanks insured by electrostatic heating of laminated sheets

• Using high frequency heating, Formica Insulation Co., Cincinnati, has developed a method of welding together a number of relatively thin sheets of Pregwood into a solid block from which airplane propeller blades are formed. Ability to heat the entire mass uniformly while the material is in the press, Formica engineers assert, is the basic improvement of the method.

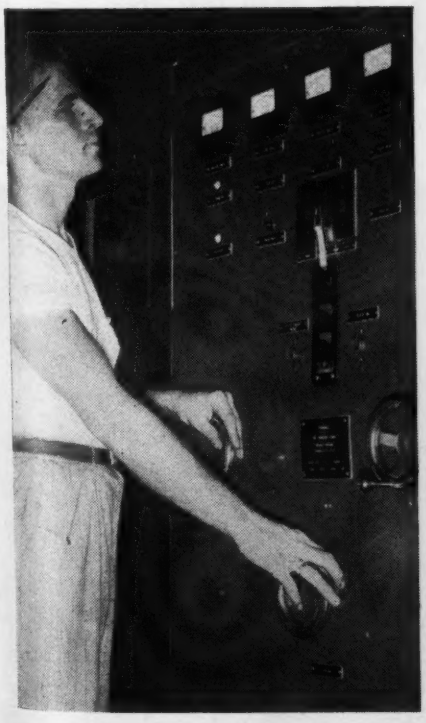
The equipment installed to do the job, made by the Girdler Corp., Louisville, Ky., is a 30 kva Thermex machine in which the self-excited oscillator operates at 1.74 mc and delivers 15 kw to the plates between which the Pregwood is heated. A thermosetting glue is used and the heat is generated in the material itself rather than being applied from the outside. This results in the entire mass heating uniformly.

The blocks as they are put into the hydraulic press measure 52 in. long, 10¼ in. wide and 6¼ in. thick. A single oscillator serves three presses, being switched from one to the other to permit continuous operation. The input to the plates of the 892 power tubes is 27 kw. The plate supply is a three-phase full wave rectifier using Amperex tubes.

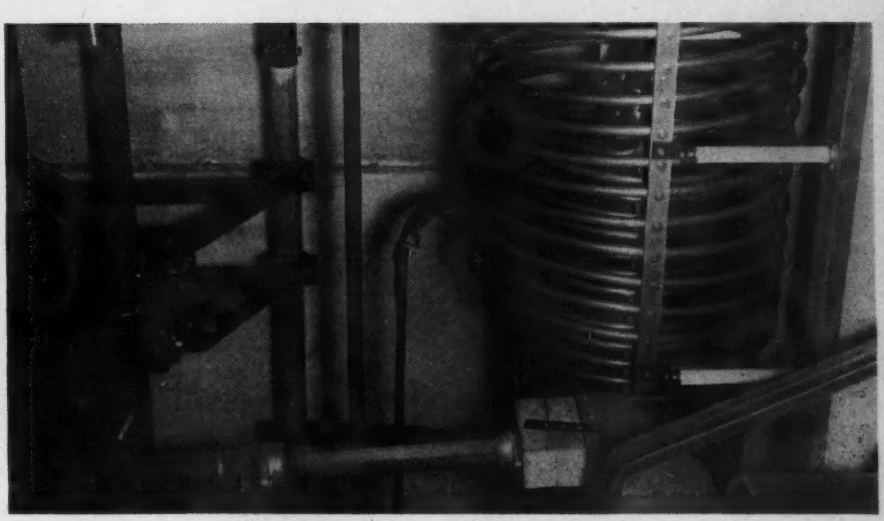
Showing position of copper plates on each side of block



Battery of hydraulic presses with Pregwood blocks surrounded with thermal installation ready for gluing



Control board of the installation which is arranged for switching the high frequency generator to either of 3 presses, providing for continuous operation



View showing part of high frequency heating machine

HOW UTILITIES USE RADIO

by A. B. BUCHANAN
The Detroit Edison Co.

Detroit Edison makes wide application of electronic equipment for surprising variety of company purposes

• Few persons not intimately connected with the internal affairs of large public service organizations have any real idea of the extent to which radio and electronic devices of various sorts are used by such companies for their own purposes. This company is a case in point.

Here, for example, are just a few of the ways modern electronic facilities are being used at present by the Overhead Lines Department to reduce the cost of installation and maintenance of equipment and to improve service in general, with the probability that the list will be far extended in the near future:

Ground locators are used to impress a signal on a grounded circuit of our normally ungrounded three-phase 4800-v distribution system, and the signal is traced to the ground.

Portable X-ray equipment is used to determine the condition of poles in which decay might be suspected at the groundline.

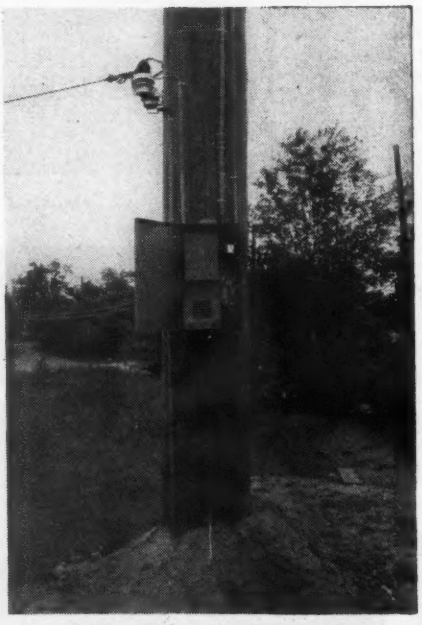
Photocell controls are used to operate the majority of the street circuits in our entire territory.

Electronic devices are used to help predict the approach of electrical storms.

The performance of experimental street lights is checked by electronic means and lamp washing and replacements are determined on the basis of electronic measurements.

We have experimented to some extent with electronic devices for determining how close the auger of a digging machine is to buried pipe in order to avoid damage to the pipe.

Public address systems are used to quite a large extent, and a well-equipped radio laboratory is used not only for the maintenance of our radio equipment, but for developing new devices to meet the problems which arise.



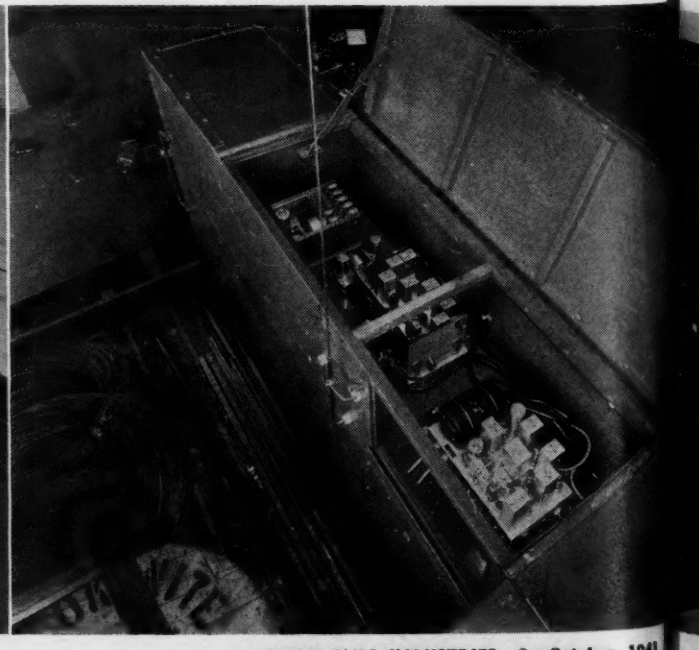
One of the 8 pole-mounted weatherproof FM receivers

Two-way FM system

Perhaps the most spectacular use of radio is in the Overhead Lines Department. This is a complete two-way FM emergency communication system by means of which any desired truck can be reached in the event of an emergency. An emergency involves a hazard or potential hazard to life or important property.

One of the principal differences between a two-way system used by a public utility and that used by a police department is that the utility company crews are normally not in their trucks when they are called. Consequently it is necessary to call the particular crew to the truck when that crew is wanted. This is done in our case by means of a selective call system, and supplemented by an "alarm unit."

Dispatching normally is handled from this radio control console



Arrangement of equipment in a mobile FM installation

The system, at present, is in use only in our Detroit district. Several other cars carry only receivers and selective call equipment. At the dispatching point is a map of the district mounted on a steel plate, and a number of Alnico magnets are numbered and placed on this steel-backed map to show the positions of the various trucks. As the trucks move about, the magnets are moved correspondingly.

Selective truck calling

In the event of an emergency, a dispatcher glances at the map to see which crews are closest to the scene of the trouble. He then pushes buttons at the radio control console to correspond to the selective call number of the desired truck. This automatically turns on the transmitter, transmits the selective call signal, and then automatically shuts down the transmitter.

The selective call decoder, on the truck wanted, closes a 6-v circuit, energizing the "alarm unit," sounding a buzzer, and sounding the truck horn in a series of short "beeps" at about six second intervals. One of the crew, on hearing his horn blow, goes to the truck, picks up the hand set of his transmitter, and gives his number and location. The dispatcher then tells him what is wrong and the crew is on its way immediately.

Normally the crew takes care of the trouble and then reports back to the dispatcher by radio giving a brief description of the trouble and what was done about it. In case more help is needed the crew calls the dispatcher and an additional crew or crews are dispatched.

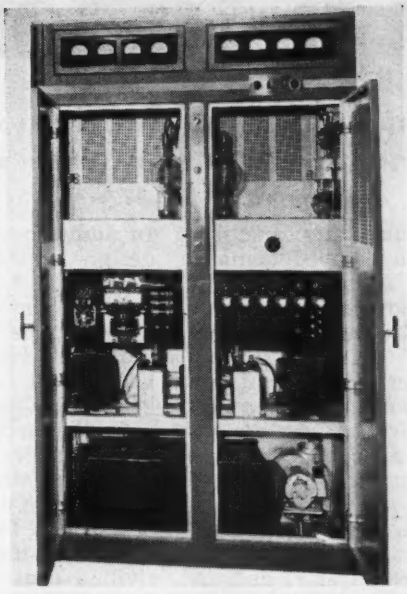
The system consists of a 3-kw FM main transmitter, about forty-five mobile transmitters mounted in trouble trucks having two-man crews, and eight remote receivers scattered at strategic points throughout the area served. The antenna at the main transmitter is a ground plane type with reflector mounted on a 200 ft. tower, which, in turn, is built on top of a 30 ft. warehouse building. The purpose of the reflector is to send the bulk of the energy to the north where the greatest distances are involved, so that as the system is expanded to include suburban territory, the coverage will be more uniform.

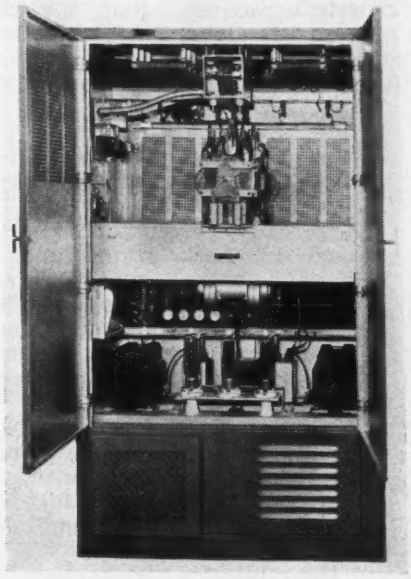
Telephone line control

For future expansion of the system to other districts, using the same main transmitter, we must use our private telephone lines for voice and control in such a way that the lines are tied up only while the transmitter is being used. The block diagram shows a scheme we have tried successfully, using a 1000-cycle tone for control. At the transmitter end, filters separate the voice from the 1000-cycle control current. The 1000-cycle tone is on the wires continuously while the transmitter is on the air, but is barely audible in the receivers.

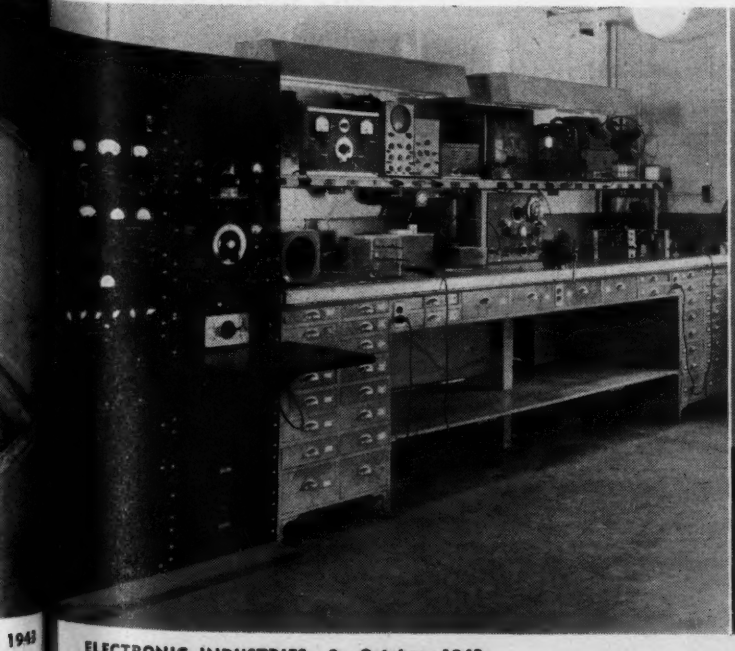
On our older trucks the mobile transmitting and receiving equipment is mounted in a steel box, but in the newer trucks a special compartment has been built to house the radio equipment, including

(*Continued on page* 154)





3 kw FM main transmitter



An extensive laboratory is maintained for service work

Main transmitter with local control console for emergency

POSTWAR RADIO SETS

Well-known industrial designers express their views on principles which will control design. See market for 16-20 million sets

• If civilian-radio production should start within a year, the radio industry will face a delayed demand of nearly fifty million sets! Such a figure is easily justified by our 14-million-set production in 1941—the last year civilian-radio manufacturing was permitted to operate full-tilt.

Industry leaders will not be surprised then, if the first years of postwar radio manufacture roll up annual totals of 16 to 20 million receivers. This is mass production on a scale equalled or approached by no other comparable product in civilian life.

Experience in mass production of automobiles, electrical appliances, office equipment, and also radio, has indicated that mass demand for a product can be greatly stimulated and increased by physical designs which appeal to buyers, and particularly to women.

Good engineering principles and tone quality alone, it appears, are not sufficient for commercial success with a home radio that seeks a huge mass market. In addition there must be attractive outlines, artistic design, appealing new materials and color combinations, and convenience of control,—from the standpoint of the customer.

It was the introduction of these elements by skilled industrial designers (who at the time may have known little about radio) which resulted in the sudden spurt in the radio-set sales curve ten years ago.

In the decade since, radio production has enjoyed the attention and ministrations of these industrial designers, whose ideas have supplemented the basic engineering design and have resulted in many desirable new selling features.

Recognizing that a new and outstanding era of civilian-radio production may be upon us before very long, the editors of "Electronic Industries" have invited representative industrial designers to let us publish their comments on the directions which postwar civilian radio should take.

Radio-Tele-Recording

by RAYMOND LOEWY
580 Fifth Avenue, New York, N. Y.

Shown herewith is a combination radio, television and recording unit, designed for the Continental Radio & Television Corp.

The unit is operated directly by push-button or by remote control, a detail of which is encircled. This remote control can regulate volume, tone and tuning of radio and television units. Records are set up in vertical position, as many as thirty at a time. A system of dual tone arms plays both sides in order. Additional records are stored in drawer space at each side of the cabinet.

Precision Instrument

by GILBERT ROHDE
Bay Drive, Huntington, L. I., N. Y.

After the war, design—formerly stifled and twisted in the radio field—will be free to function here as it has so successfully in other industries.

My prediction is that even the larger cabinets for radio will no longer masquerade as a chest of drawers or a sewing cabinet. Manufacturers will no longer have to tell their designers to "make a cabinet as Chippendale would have made it, if there had been radio in his day."

The radio will be an instrument in its own right. The predominating feeling that instrument is to convey is one of precision. The cabinet must say—"I am a fine piece of engineering; I get all the music to you just as it was played; I am a precision instrument." Psychologically, we will have been prepared for such a machine, for thousands of our young men, and now young women too, have been exposed to the trim and business-like appearance of radio in military units, the radio and instrument panels in airplanes.

Of course we can't do the job by transplanting an airplane radio case, lock, stock and barrel, into the front parlor. It will take very competent design to embody in one unit, the feeling of precision found in the military radio and also the feeling that this instrument belongs in a home.

Civilian Walkie-Talkie

by MONTGOMERY FERAR
Sundberg-Ferar, Detroit

The Walkie-Talkie radio transmitter and receiver is our suggestion for a future radio design.

Applications of this compact, plastic-cased Walkie-Talkie in providing two-way wireless communication are almost unlimited. A few of the most obvious uses would be for plant executives, construction gangs, firemen, police, forest rangers and farmers or ranchers.

The design utilizes a carrying strap as the antenna. A conventional head set is provided which houses the microphone and receiver. A loud speaker can be switched on or off as desired.

We think this application of a wartime development will be an extremely useful contribution to communication in the postwar world.

Esthetics and Values

by JOHN VASSOS
(Major, Corps of Engineers), Norwalk, Conn.
Former RCA Consultant

Radio and television after the war will change little in principle. Added facilities, naturally, will be incorporated, without making the device a "Rube Goldberg" affair.

The time element which is so related to the function of radio will

1. LOEWY—"Combination radio, television and recording unit." 2. FERAR—"The Walkie-Talkie . . . will be a wartime development." 3. DREYER—"With function its first consideration." 4. LESCAZE—"Formed by three basic units." 5. JENSEN—"A music lover's instrument." 6. ROHDE—"Postwar set that will not be produced."

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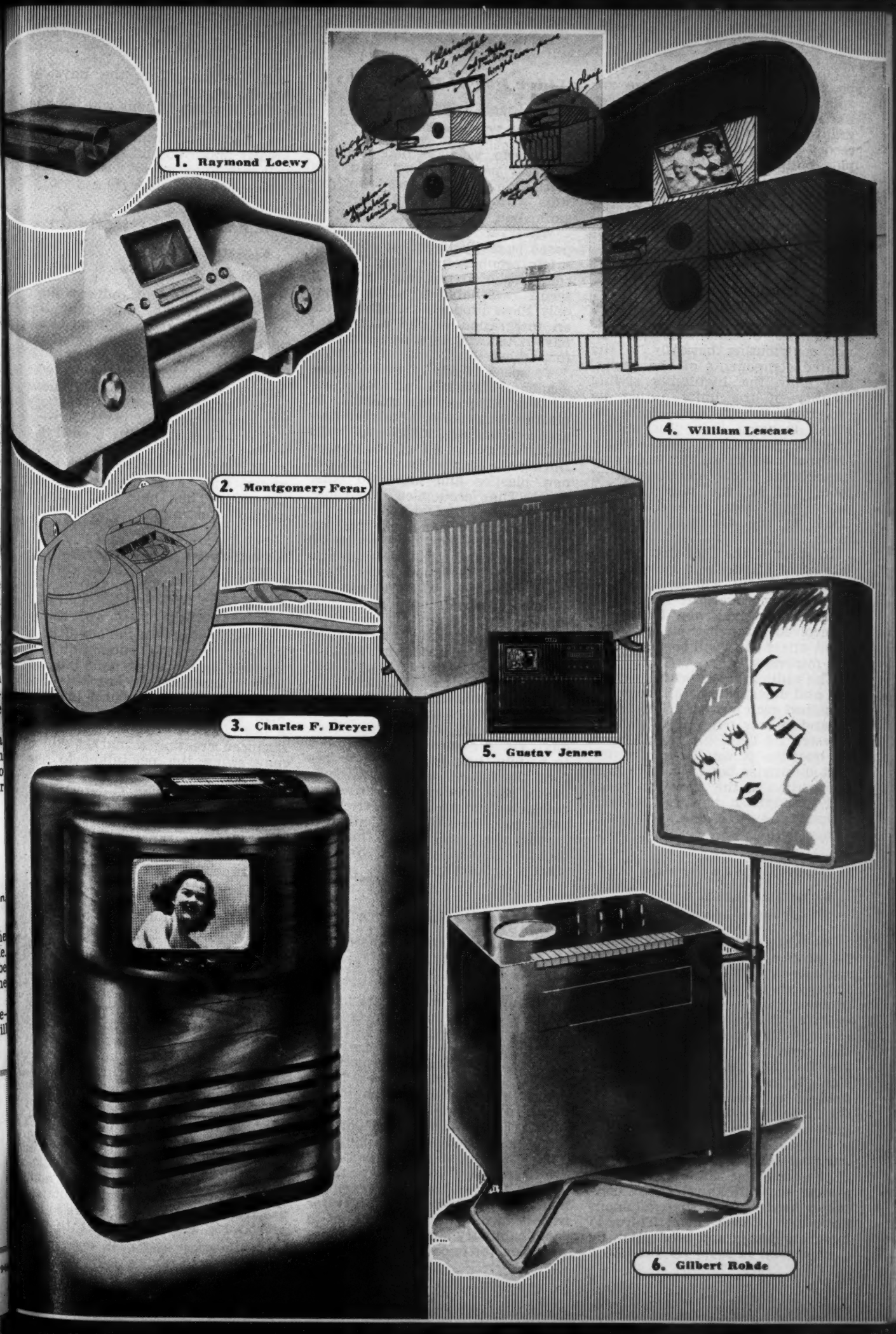

1. Raymond Loewy
2. Montgomery Ferar
3. Charles F. Dreyer
4. William Lescaze
5. Gustav Jensen
6. Gilbert Rohde

be given great study and we are going to have some unique devices like time-tuning, pre-arranged programs and the like. The automatic record-playing device definitely will play both sides. Television should have a much larger image and for that we can look forward to the projected screen, rather than the sharp but much smaller cathode-tube screen.

As for style, we are headed for functional design with all the nuances that are necessary in the evolution of a product that has so many mechanical and electrical accessories. Streamlining, although not contributing basically to the related components of the device, may play the highlights styling identity of the units during its evolution. For the great audience, which is going to be the middle bracket, progressive units which eventually will make up the decorative scheme of the American living room will be the most popular items and great care should be taken in the designing of these units.

In spite of the fact that we are talking of plastics and metal, I believe wood still will be the material to construct the housing of these units. Many new forms will be evolved through the use of plywood where costs will be reduced to the minimum.

The radio industry with its vitality and imagination, already had launched such a program as I refer to and it was only this war that arrested its development. There is no question it will be one of the first industries not only to reclaim its position in the American home but to establish new values, both esthetic and material, in our life of tomorrow.

A Step-by-Step Design

by WILLIAM LESCAZE
211 East 48th Street, New York, N. Y.

An increasing number of manufacturers are working with the assistance of planners, architects, and industrial designers on the vital problems which will confront all of us after the war.

Generally speaking, efforts at this time are threefold: research and fact-finding, analysis, and design. It seems to me that in the field of postwar radio production, the industrial designer has three important tasks. First, to establish a better relationship between industrial technic and the budget of the consumer. Second, to obtain a more accurate knowledge of consumer needs and of the equipment necessary to meet them. Third, to integrate design and production by

(*Continued on pages* 148 *and* 150)

Wider Use of Plastics

by MORRIS SANDERS
219 East 49th Street, New York, N. Y.

Hitherto, we have had good radio sets poorly housed, and vice versa. We have achieved our results with and without plan, organization, and design.

Whatever else turns up after peace is really underway, one can safely prophesy one thing—superb competition in the radio field. It seems reasonable to assume that only those products resulting from an integration of the elements I have noted will stand a real chance for success.

To speak briefly of two of those elements, materials and design, our postwar prospects are splendid. In plastics, we have a large materials group eminently suited to radio manufacture in all of its phases. During the war we have developed new plastics and improved older ones. The economical, saleable, and practical advantages of the materials have become better understood by industry, generally. The radio and plastics industries practically grew up together. They know each other well and will undoubtedly become even more intimate in the future.

A word on design—design in the Oxford Dictionary sense of "adaptation of means to an end": our qualified industrial designers face a world of materials and fabricating and merchandising methods that grows a bit more complex each day. Yet they are better equipped to handle their jobs than ever before. Fortunate will be the companies that relate the engineering, research, and design electrons in their parallel orbits around the management proton for they are constructing the atomic base of successful postwar sales.

Postwar Design

by BENJAMIN SIDNEY NASH
51 Fifth Avenue, New York, N. Y.
Former Philco Consultant

Having spent many years in developing the annual cabinetry and visual aspects for radio sets, I prefer not to predict or visualize what radio will be like, several years hence, after the war is over. There are too many influences other than design, to guide these developments. Should the channels of distribution or radio selling methods vary from those of the past, the visual aspects of radio will be made exactly to meet these new requirements. Any radio manufacturer who is looking for guidance as to radio cabinetry should keep a close watch on the oncoming "considerations" which affect the physical aspects of radio.

These considerations will include the following:

1. Radio performance will be greatly improved and the cabinetry will seek to outwardly visualize the

(*Continued on pages* 148 *and* 150)

Put Faith in the Designer

by GEORGE SAKIER
9 East 57th Street, New York, N. Y.

On the subject of radio cabinet design, we can be sure that the postwar small radio will be compact, have gadget appeal, be smart or snappy, and be a good buy.

We can be sure that the postwar large radio will have the ultimate in conveniences and must satisfy the owner's pride of possession.

How to get this? Hire a good designer who really knows how to work with the factory and really understands what people like to live with. Then help him all you can and trust him.

Functional Approach

by J. O. REINECKE
Barnes & Reinecke
664 N. Michigan Ave., Chicago

I fear tomorrow's radio will be a let-down for the public, quickly followed by almost extreme models. Most manufacturers are thinking in terms of chassis tooled in 1941, with only minor cabinet changes. A few "pioneer" models will be introduced creating a market which may swing the pendulum to the left.

The logical design is determined by three elements: (1) the electronic unit, (2) sound reproduction, (3) appearance. Probably the richest market lies between the expensive model, and the cheap, economically-dangerous set of poor reproduction.

The demand for better music by the public and a growing appreciation of tonal quality, suggests greater stress on speaker quality, resonance chambers, and other factors which affect the audible elements of a radio. Greater stress will be laid on research in sound, possibly under the direction of a competent musician who will complement the engineer in charge of the electronic unit. Knowledge, not necessarily cost, may easily improve sound reproduction immensely.

From an appearance viewpoint a radio should look like a radio. Pianos, refrigerators, bathtubs, and designs of other household items are frankly themselves. There is no reason for a radio cabinet to re-

(*Continued on pages* 148 *and* 150)

DC Motor Operation on AC

by B. J. DALTON
Electronic Section, General Electric Co.

Design and operating features of tube equipment which permit great flexibility with 100 to 1 speed range

• An ac power supply, an electronic control equipment, and a dc motor combined in a Thy-mo-trol drive will provide a continuous speed range of as much as 100 to 1. The inherent characteristics of this type of drive allow pre-setting at any operating speed and assure that that speed will be maintained within an extremely narrow margin through the range of no load to full load. Current limit enables the drive to accelerate smoothly to the pre-set speed and prevents loading beyond a safe value.

This electronic drive has already been applied with considerable success to lathes, grinders, milling machines, testing machines of different types, and to many other equipments. The following short descriptions of a few typical applications should serve to indicate its capabilities.

Testing machine

A manufacturer of material-testing machines had been unable to find a drive having a wide speed range and at the same time the ability to hold the desired speed regardless of load. Rigid testing specifications require that a test on any particular sample be conducted at a constant rate of elongation. To meet these specifications, it was necessary that a speed, set initially with a low torque, be held constant up to the maximum torque or "yield" point and then through a range of diminishing torque until the sample broke.

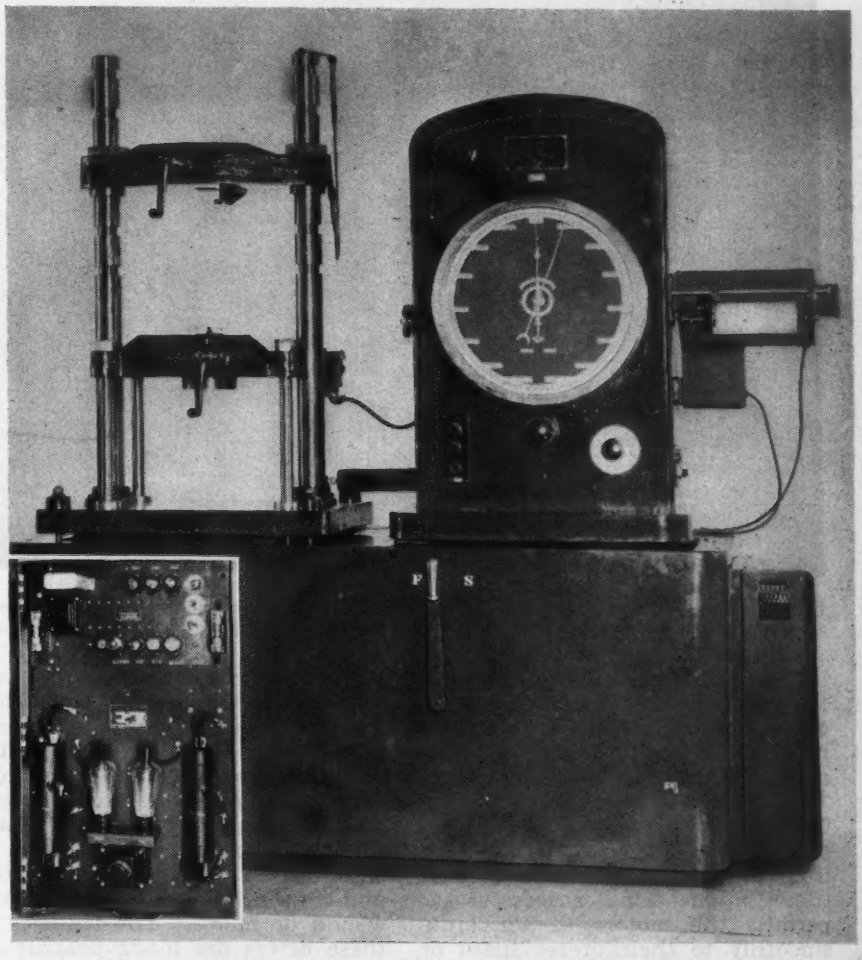
In testing a Thy-mo-trol drive applied to a 60,000-pound tensile strength machine, a large rod was placed in the machine which was started with the speed control in the one-inch-a-minute position. Throughout the test, the speed was observed on a portable tachometer and although at the "yield" point the motor was overloaded twenty-five per cent, no variation in motor speed could be detected.

The varied cuts and passes required in milling an airplane spar make it imperative to vary over a wide range, the speed with which the spar is moved into or away from the cutter, if the time of producing the spar is to be a minimum. The spar must be fed slowly, yet steadily, during a heavy cut. It must feed faster through a light cut and traverse both forward and reverse at a maximum speed.

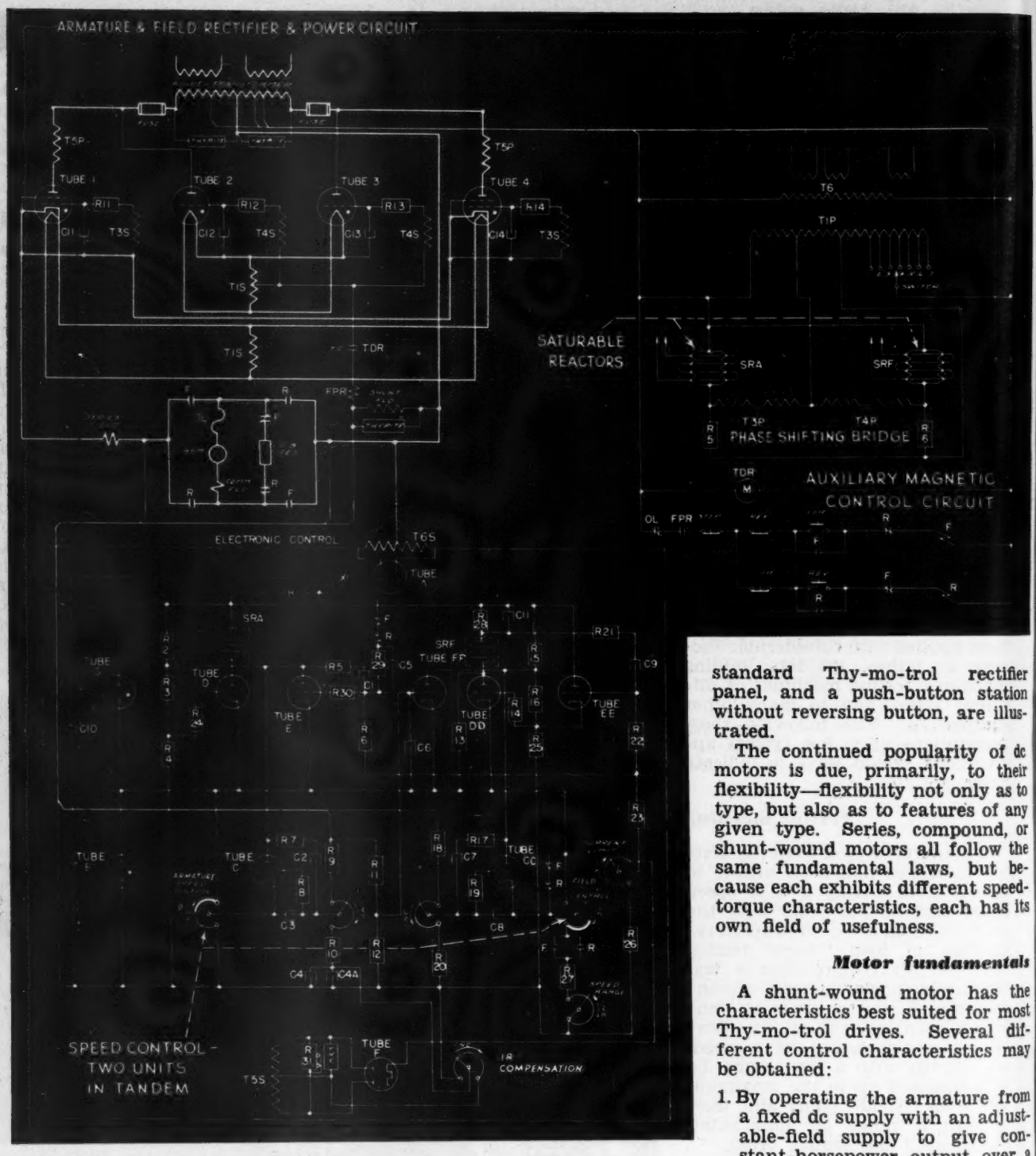
Magneto testing

This wide range is obtained by the turning of a single small shaft which varies the speed from almost zero to a maximum. This permitted a template to be made so that the speed-control potentiometer, through an arm and pinion arrangement, follows a predetermined speed program pattern, so that the overall time-cycle is a minimum.

The testing of magnetos requires that they be operated over approximately a one-hundred-to-one speed range. In order to save time, it is essential that a number of predetermined speeds be selected easily and quickly. A multi-position tap switch, connected to a number of different speed-control units, allows each speed to be individually adjustable, yet allows accurate and almost instantaneous selection of any of these preselected speeds to make a definite test-



Heavy materials testing machine powered by 2 horsepower motor and Thy-mo-trol drive. Inset shows control for start, stop and speed changes



Basic equipment connections for the Thy-mo-trol electronically controlled variable speed motor drive, with auxiliary control features applicable to a 1 hp dc motor

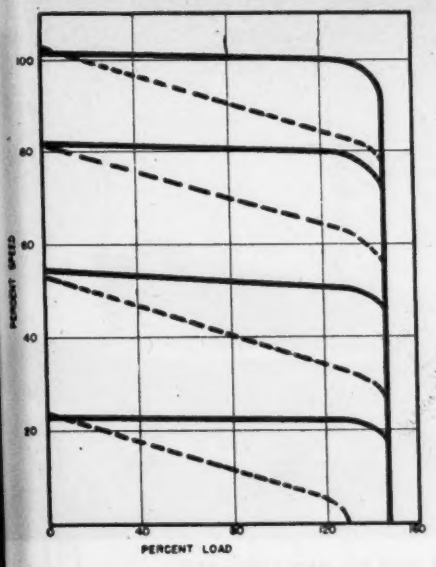
ing program. The magneto manufacturer who has installed several of these drives on his test stands is now able to complete the tests in a much shorter time than before. The current-limit feature of the Thy-mo-trol drive which introduces such effects as a motor torque limit is an important factor in making these applications successful. It permits the motors to accelerate smoothly to their preset speed or to reverse at a pre-determined current limit. A complete Thy-mo-trol drive consists of an anode transformer to change the available power supply into a voltage which when rectified will be suitable for application to the motor; an electronic rectifier and control unit to supply controlled dc power for the motor; a control station to start, stop, or reverse the motor, and control its speed; and a shunt-wound dc motor. The features of these drives are made possible by the coordination of the design of the motors and the control. A standard Thy-mo-trol rectifier panel, and a push-button station without reversing button, are illustrated.

The continued popularity of dc motors is due, primarily, to their flexibility—flexibility not only as to type, but also as to features of any given type. Series, compound, or shunt-wound motors all follow the same fundamental laws, but because each exhibits different speed-torque characteristics, each has its own field of usefulness.

Motor fundamentals

A shunt-wound motor has the characteristics best suited for most Thy-mo-trol drives. Several different control characteristics may be obtained:

1. By operating the armature from a fixed dc supply with an adjustable-field supply to give constant-horsepower output over a four-to-one, or in special cases over as high as a six-to-one speed range;
2. By operating the armature from a variable-voltage supply and the field from a fixed source to give a constant torque or variable horsepower output over a range in speed of about ten-to-one conventionally, or about thirty-to-one electronically;
3. By operating both the armature and field from independently adjustable dc power supplies, to give a combination of constant torque over part of the range



Speed regulation curves with (solid line) and without (dotted line) IR drop compensation

and constant horsepower over the other part of the range, or to give constant torque at a reduced value over the entire range.

If we assume that the current flowing in the motor armature is constant, these three results can be proved by the following analysis.

If the effect of armature circuit resistance and field resistance changes due to temperature are neglected, the following relations illustrate the operation of a shunt-wound dc motor:

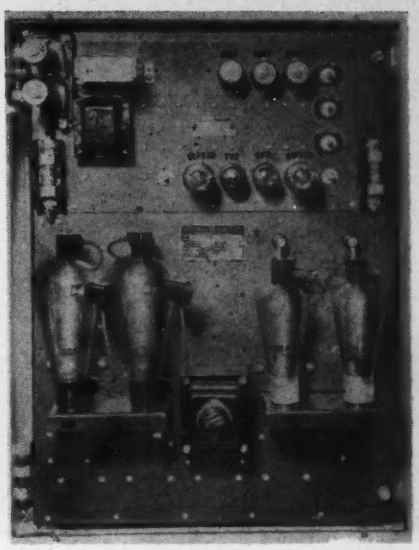
$$\text{Shaft Speed} = K_1 \times \frac{\text{armature voltage}}{\text{field voltage}}$$

Shaft Torque = K_2 x armature current x field voltage

$$\text{Shaft Horsepower} = \frac{\text{shaft speed x shaft torque}}{5250}$$

(K_1 and K_2 are fixed constants for any particular motor)

Neglecting losses, these relations may also be demonstrated electrically by using a dc ammeter to measure armature current and a dc voltmeter to measure armature voltage. The product of the ammeter reading and the voltmeter reading represents power output. As long as the field voltage and the armature current are held constant, varying the armature will vary the horsepower output. If armature voltage and armature current are held constant, the field voltage may be varied to give a change in speed. In other words, although the speed changes, the power input and output remain constant.



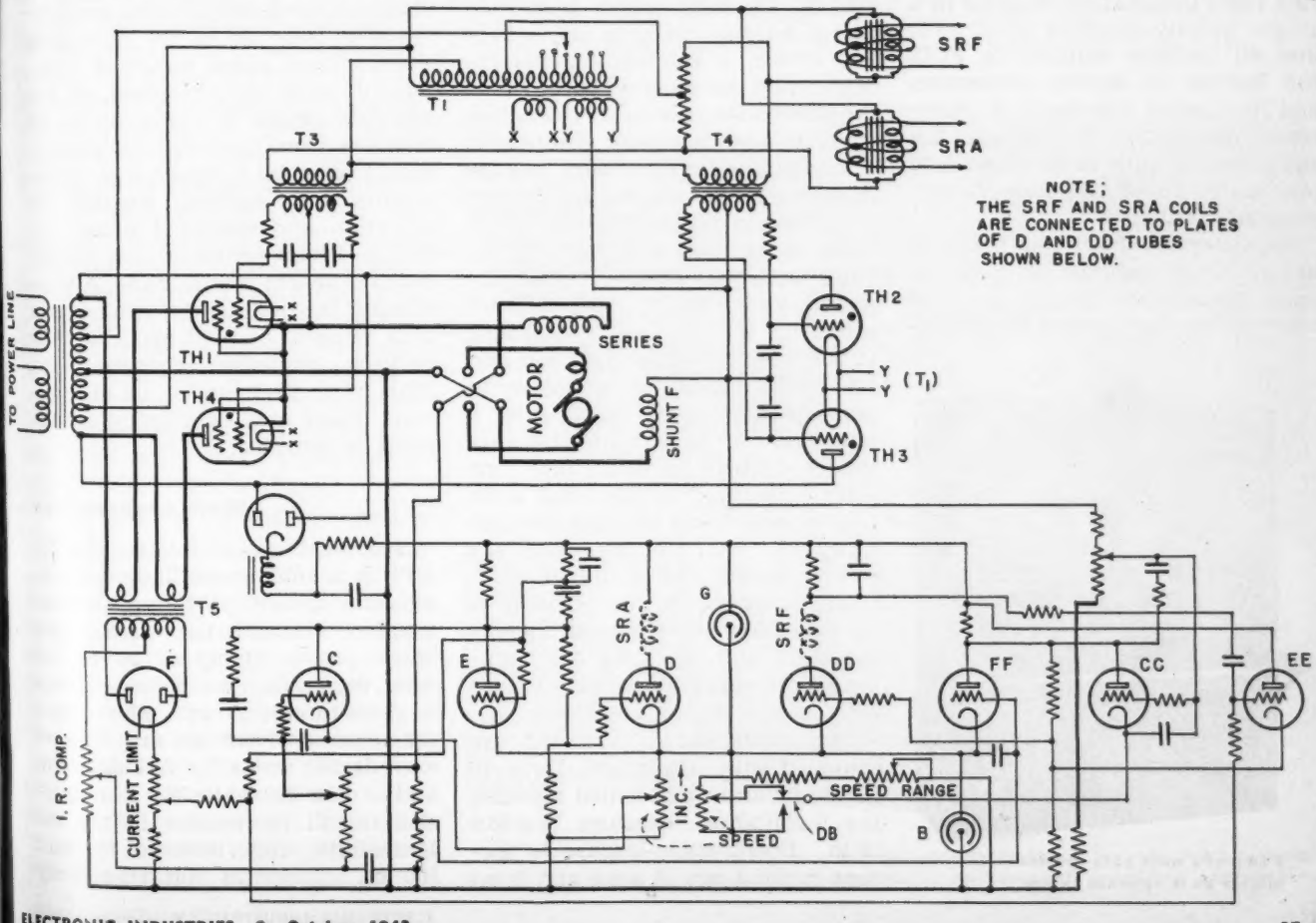
Standard type of Thy-mo-trol heavy-duty control panel

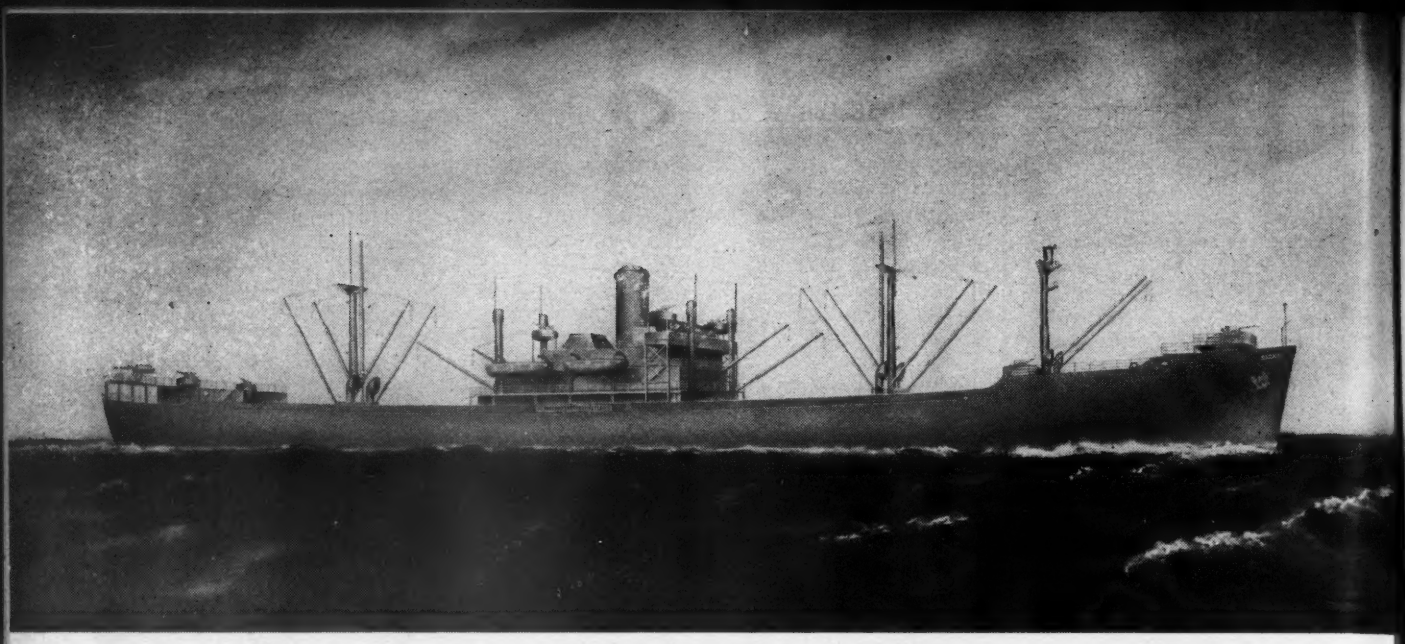
Control operation

Although flexibility is obtained through the use of a dc motor, features provided in typical Thy-mo-

(*Continued on page* 174)

Schematic of the Thy-mo-trol motor drive. (Editor's note: This circuit is identical with diagram on opposite page but uses circuit symbols that are common to the communication field—added for those engineers who have difficulty working with the power group symbols.) The switch DB refers to automatic dynamic braking contactor





Victory ships of this type, building in large numbers, are to be equipped with the new radio unit

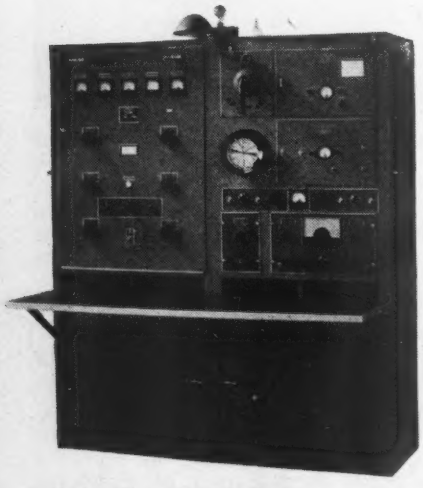
PACKAGED MARINE RADIO

by ELMER F. LEWIS
Chief Marine Radio Engineer
Federal Telephone & Radio Corp.

New unit equipment, designed for Victory ships, self-contained in single cabinet for easy installation

• First attempt at a completely packaged unit, Federal's new marine radio installation contains in a single quickly-installed steel cabinet all features required by FCC, the Bureau of Marine Inspection and Navigation and the U. S. Maritime Commission for whom the equipment is built to be fitted into practically all of the new Victory ships now building.

Facilities required and included in the unit embrace a complete main transmitter for cw and icw transmission, an emergency transmitter for the same services, motor generators, emergency "B" battery supply, an auto alarm and auto alarm selector, an auto alarm keying device, a communications receiver and an emergency receiver, together with necessary switches, controls and patching equipment.



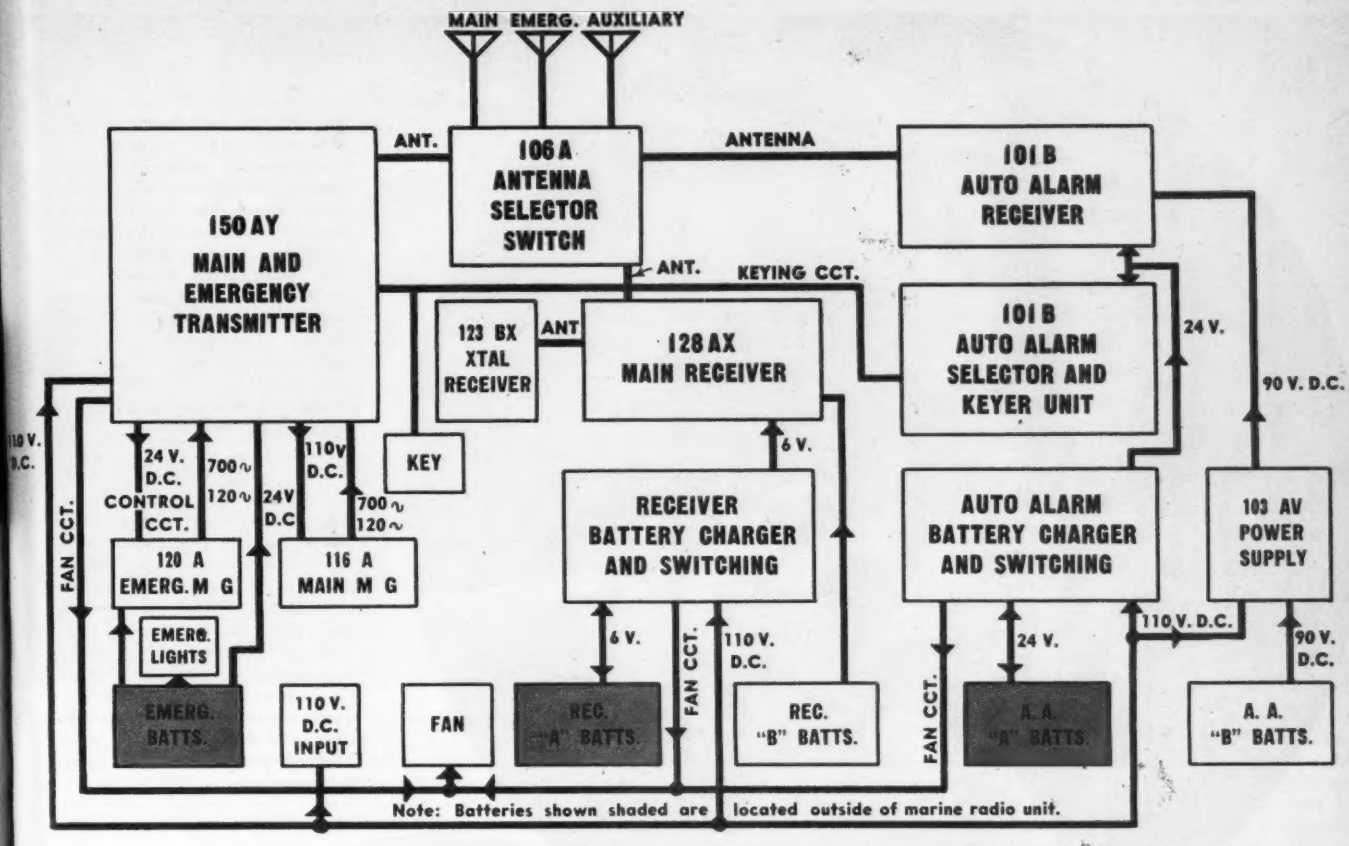
Federal's unit ship transmitter as it appears in use

Except for the necessary storage batteries which usually are located in a battery room adjacent to the radio room, the equipment is entirely self-contained. It was designed and built in this manner primarily for ease of installation. It is supplied completely wired and practically ready for operation in two separable units, which, after a minimum of interconnection are solidly bolted together into one piece. Reason for the two units was to permit easy passage through doorways, etc. Another advantage of this design plan is that it effectually standardizes the position of all operating controls and thereby simplifies and expedites the training of operating personnel. It also facilitates servicing operations.

The individual cabinets are equipped with lifting eyes for easy handling, and when bolted together the installation measures 72 x 58 x 19 in. Doors, triple-latched to prevent rattling, are at sides and front to permit quick access. Compartments for storing message forms, stationery and publications are provided at the rear of the operating shelf. Each panel mounted component, with the exception of the antenna switch, is arranged to be removed from the front for adjustments or parts replacements. Generators and starters, treated for vibration and electrical noise, are in the lower section where provision for spares also is made. A ventilating fan within the cabinet assists removal of heat generated by battery charging circuits, etc. Emergency illumination of all controls, fuses and emergency equipment is provided.

Main transmitter

The main transmitter (model 150 AY) is a master-oscillator power-amplifier design, providing for telegraphic transmission, using the ship's power supply of 90 to 120 volts dc, or its own battery power in cases of emergency. The output for operation from the ship's power exceeds 200 watts for A-1 emission and is over 300 watts for A-2 emission on all frequencies in the intermediate range between 350 and 500 kc. Under 24 volt emergency



Block diagram of the complete circuits used in the Federal marine transmitter unit which provides for telegraph communication and an automatic alarm system

battery power, the output is over 50 watts, A-2 emission.

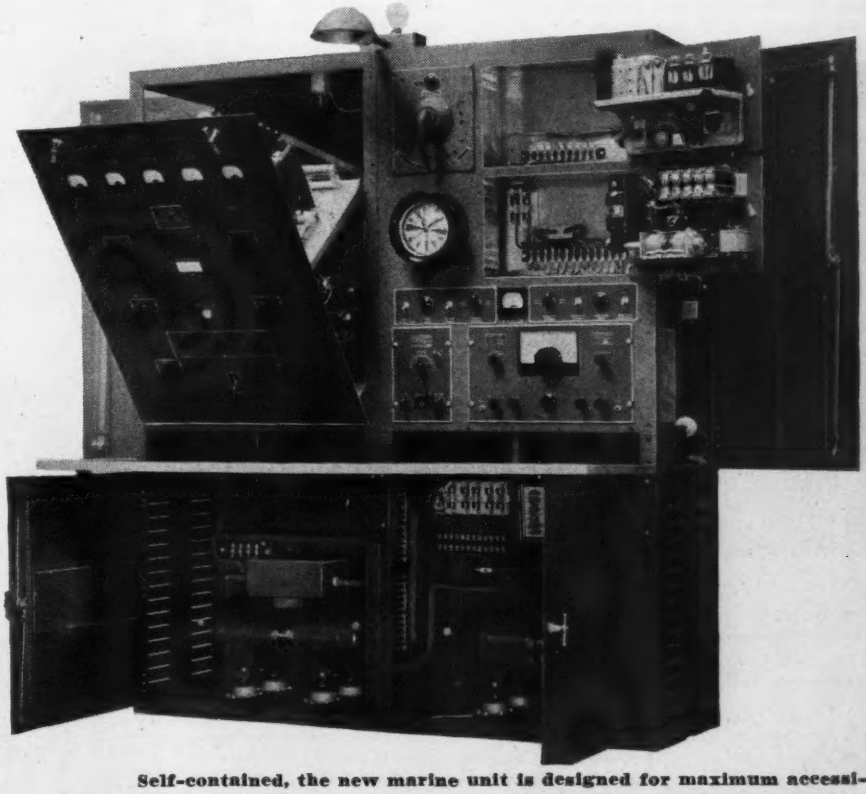
The design provides for quick change to any one of five frequencies in the range between 350 and 500 kc with a maximum frequency deviation from a pre-set value within plus or minus .1 per cent due to all causes, such as antenna tuning, temperature variation, vibration, plate and filament voltage variation, modulation and keying. Break-in operation is provided with a relay interconnected with the antenna. Antenna tuning arrangements provide for transferring power to any type of antenna of from 600 to 1500 mmf equivalent capacity and 1 to 14 ohms resistance.

Power supplies

The transmitter circuit includes a low power master oscillator of the tuned-plate, untuned-grid feedback type using a 210 or 801 tube; an untuned buffer amplifier, using an F-123-A tube; and a final amplifier using two F-123-A tubes in parallel. Included in the transmitter frame are the necessary rectifier and filter components embracing a single phase full wave mercury rectifier with a single section filter and a modulation transformer to plate-modulate the final stage.

The main generator, mounted on rubber vibration cushions, is a single unit motor-alternator supplying 200 volts at 720 cycles for plate power and 75 volts at 120

(*Continued on page* 152)

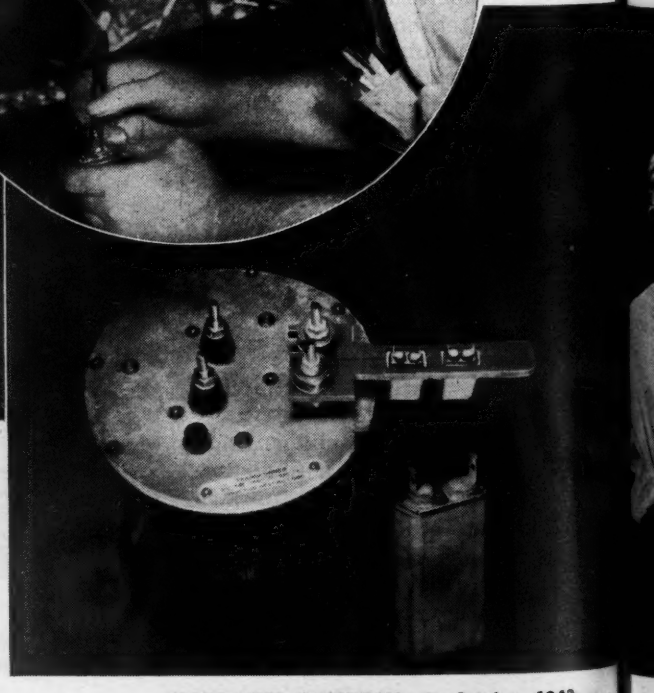


Self-contained, the new marine unit is designed for maximum accessibility and the easy replacement of essential operating components

1. "Lilly jig" broke bottleneck in the placement of filaments in miniature type tubes. Formerly a troublesome hand operation, accurate positioning of the fragile filaments is now done in far less time with help of the guiding jig and the buzzer which vibrates the wire into place. Annual saving of 12,600 "woman hours" will be the result in Newark, N. J., Tung-Sol plant. Device is covered by patents

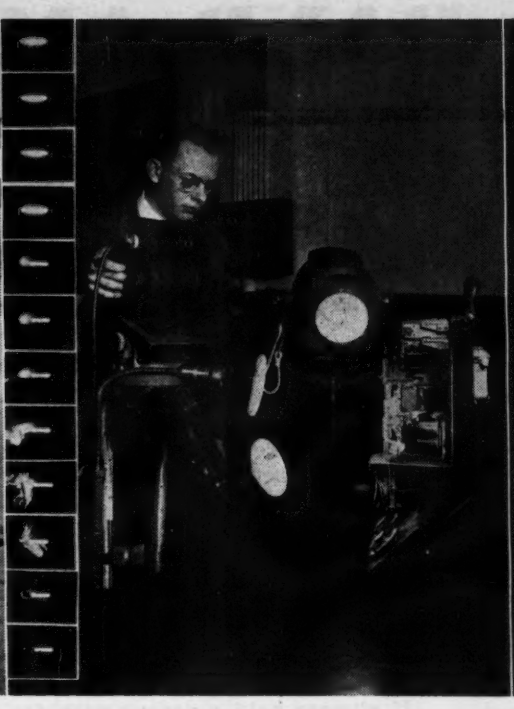
2. Removing oxide from .001-in. resistance wire on potentiometers and rheostats is accomplished safely at plant of P. R. Mallory & Co., Inc., Indianapolis, Ind., with glass-fiber eraser made for typing use by the Eraser Co., Syracuse, N. Y. Glass-fiber eraser is only dependable abrasive that will give desired finish and not harm delicate wire

3. Factory scrap-hound, consisting of a trailer-mounted 16 x 54 in. electro-magnet energized by a "Jeep" motor, picks up as much as 700 pounds of ferrous scrap, and saves on sweeping costs as well as reducing hazard to personnel and factory truck tires in Willys-Overland, Toledo, Ohio, plant

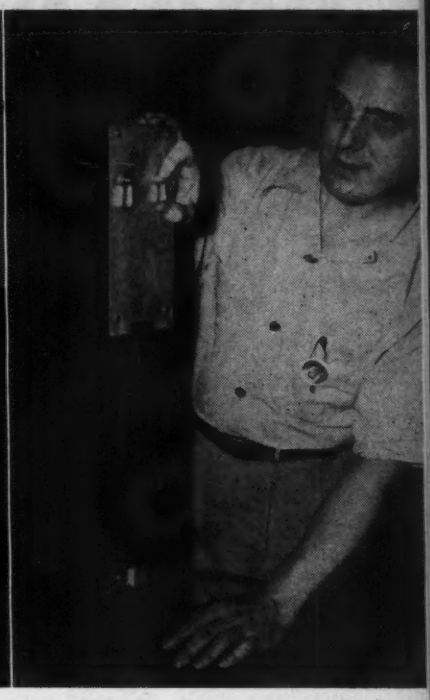


4. Induction heating reduced soldering time on condenser can covers from 16 minutes to 2½ seconds in plant of Tobe-Deutschmann Corp., Canton, Mass. Photo shows output transformer of equipment manufactured by Induction Heating Corp., N. Y. C.

5. Simplified fixture for cutting off rod or tubing at angles up to 45 deg. in metal-cutting "Do-All" saw. Versatile fixture demonstrated by W. H. Cochran, United Air Lines Transport Corp., Cheyenne, Wyo.



6. Fastax motion picture camera developed and improved by Bell Telephone Labs., N. Y. C., exposes 8,000 frames (200 ft. 16mm. film) in a second, for study of mechanical and other phenomena. Strip shows fuse blowing out



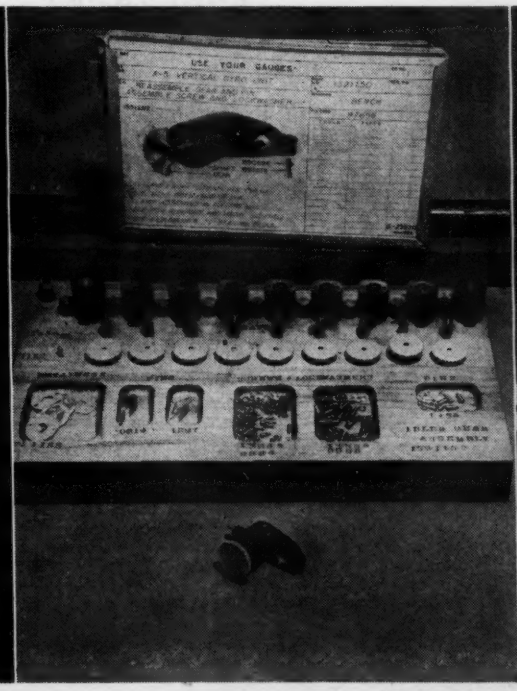
7. Differential pressure gage developed by Francis E. Pratt, Stromberg Carlson Co., Rochester, N. Y., for leak-test of pressure-sealed electronic equipment, detects changes of .001 lb. and cuts test from 4 hours to 7 minutes

FACTORY SHORT CUTS

8. Two stage, compact mercury pump developed by Walter Armstrong, Ken-Rad Tube and Lamp Corp., Owensboro, Ky., steps up high vacuum exhaust operations 25 per cent, using only a few ounces of mercury instead of several pounds in older type pumps

9. Work simplification scheme used by A-C Spark Plug Co., Flint, Mich., enables use of unskilled operators on assembly. Parts mounted on assembly board correspond to drawing on instruction chart placed in front of operator during training period

10. Building up a worn shaft, in plant of International Nickel Co., N. Y., by spraying with molten metal, with unit produced by Metallizing Engineering Co., Inc., Long Island City, N. Y. Spraying-on process salvages mismachined parts in same way



BROAD-BAND AMPLIFIERS

by MADISON CAWEIN
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Simplified method for solving general problems dealing with amplifier response characteristics — Part Two

• Considerable information is available in the literature on the comparison of magnetic-coupled with staggered-stage amplifiers.[4] This information, however, like that in regard to the design of double-tuned transformers, is not usually given in a form which is easy to use. Actually, it will be shown here that by introducing the concept of relative staggering, a pair of staggered stages can be treated exactly on the basis of a double-tuned circuit, as given in the preceding section.

Assume an amplifier having N pairs of staggered stages as shown in Fig. 4.

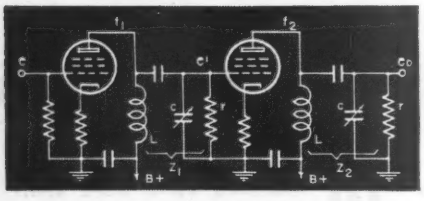


Fig. 4

Alternate resonant circuits are tuned to frequencies f_1 and f_2, such that

$$s = \frac{f_2 - f_1}{(f_2+f_1)/2}$$

where $s = \frac{\text{peak separation}}{\text{center frequency}}$ that is: the relative staggering.

The response of circuits f_1 and f_2 is plotted in Fig. 5. The scale of abscissae is in pure numbers (units of power factor, $p = 1/Q$). The scale of ordinates is in decibels (below unity response).

Expressed in terms of relative frequency, the impedance of a parallel resonant circuit is

$$(24)\quad Z = \frac{\sqrt{1+p^2}}{2\pi c f_o \sqrt{x^2+p^2}}$$

In Fig. 4 let e represent an input potential which is constant in amplitude at all values of relative frequency. Then the current through Z_1 is $i = g_m e$. This current produces a potential e′ at the second grid:

$$(25)\quad e' = iZ_1 = g_m e Z_1$$

The response of the first stage is the ratio between output and input potential:

$$(26)\quad A_1 = \frac{e'}{e} = g_m Z_1 = \frac{G\sqrt{1+p^2}}{\sqrt{x_1^2+p^2}}$$

If e′ were held constant with frequency, the response of the second stage would be obtained identically as:

$$(27)\quad A_2 = \frac{e_o}{e'} = g_m Z_2 = \frac{G\sqrt{1+p^2}}{\sqrt{x_2^2+p^2}}$$

where $G = g_m/\omega_o c$

The overall response is

$$(28)\quad A = e_o/e = A_1 A_2 = \frac{G^2(1+p^2)}{\sqrt{(x_1^2+p^2)(x_2^2+p^2)}}$$

Band width adjustment

When Q of the circuit is adjusted by means of a parallel resistor, r in Fig. 4, the factor $(1 + p^2)$ disappears from equations (24) to (28). (See relationships between x_1 and y and x_2 and y in Fig. 5. The x's relate to resonant frequency of each circuit; y relates to mean frequency of the combination.) Substitution for x_1 and x_2 in terms of y gives:

$$(29)\quad A = \frac{G^2}{\sqrt{[p^2+(s-y)^2][p^2+(s+y)^2]}}$$

which has a form identical to that of coupled-circuit response providing s be interpreted as k. This fact is more apparent if (29) be expanded into the more familiar equivalent forms, which are all identical with (29).

$$A = \frac{G^2}{\sqrt{(p^2+s^2+y^2)^2-4s^2y^2}}$$

$$(30)\quad A = \frac{G^2}{\sqrt{(p^2+s^2-y^2)^2+4p^2y^2}}$$

$$A = \frac{G^2}{\sqrt{(p^2-s^2+y^2)^2+4p^2s^2}}$$

It was shown in the preceding issue that in overcoupled circuits the ratio of dip-to-peak R_o, and also the differential peak-separation B′, may be expressed in terms of p and k. Using s for k, the equations are:

$$(31)\quad R_o = \frac{2ps}{p^2+s^2} \quad \text{and}$$

$$(32)\quad B' = \sqrt{s^2-p^2}$$

Let the differential bandwidth be defined as $B_o = B'\sqrt{2}$, which is the bandwidth shown at B_o in Fig. 5. The simultaneous solution of (31) and (32) yields two useful relations:

$$(33)\quad p = B_o\sqrt{D}/2$$

$$(34)\quad s = B_o\sqrt{D'}/2$$

Where D and D′ are the dip-functions of R_o.

Handling staggered stages

Thus, with the exception of the absolute gain-level (equations (30) may be obtained by multiplying (13) by a factor G/k), staggered-stage response is identical to overcoupled response. The number of amplifying tubes required is doubled, however, for the same number of circuits. The value of c which influences the gain constant, G, is larger for staggered circuits, since it must include both c_p and c_g. Thus, the realizable value of G is lowered in staggered amplifiers. This is usually not a problem because of the increased number of

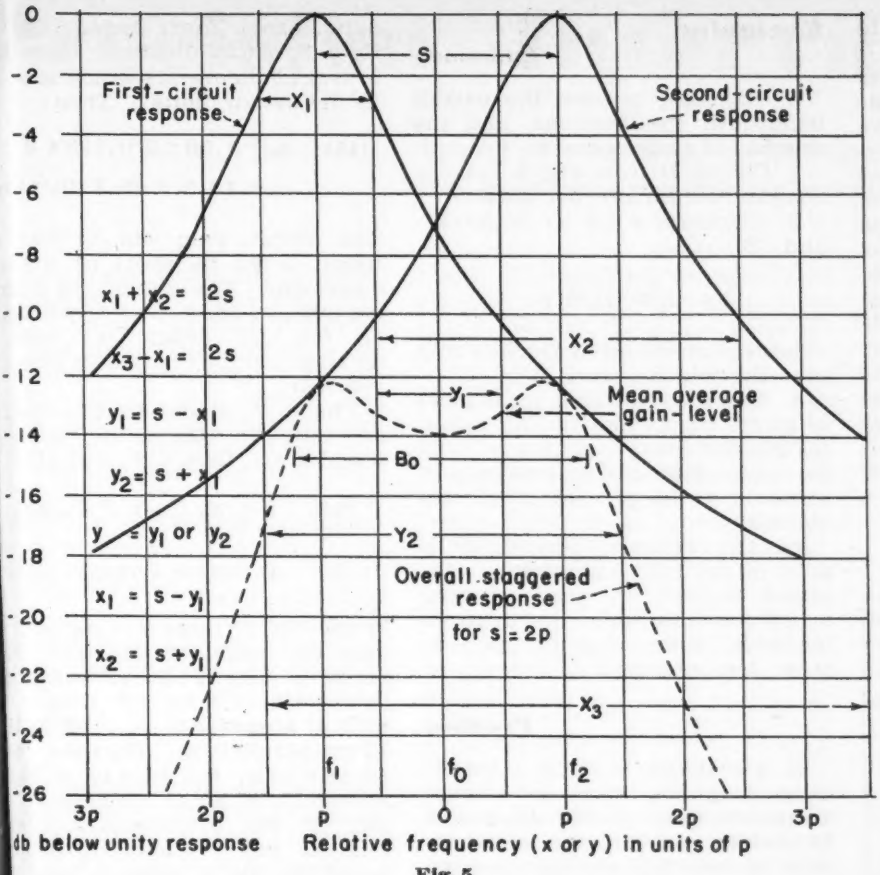


Fig. 5

tubes required for the same selectivity.

Multistage amplifiers

Consider an amplifier composed of 2N stages, consisting of N pairs of staggered stages, similar to the pair shown in Fig. 4. Let e_o be held constant (say at 1 volt). Suppose each circuit to be tuned to the center frequency, f_o, instead of to f_1 and f_2, then the square of the equation of gain [equation 28]) is:

$$(35)\quad A^2 = (1/e^2) = \frac{G^4}{(x^2+p^2)^2} = \frac{1}{(x^2+p^2)^2} \qquad /*$$

for a value of G = 1. (A^2 is the square of the overall gain for two circuits: i.e., N = 1. The square of the overall gain for one circuit would be the square root of equation (35). Thus, the shape of the response curve and of the square of the response curve depends on the number of circuits involved.)

The significance of expressing gain in terms of relative frequency instead of in terms of frequency is this: a universal response curve is obtained, in which the scale can be reconverted to frequency on multiplying the abscissae by the center frequency (f_o), and any mathematical manipulation is greatly simplified. The graph of A^2 (A^2 for one circuit), using units of p as abscissae and units of $1/p^2$ as ordinates is plotted in Fig. 6. The area of this curve is (for one circuit A^2 equals $G^2/[x^2 + p^2]$):

$$(36)\quad S = \int_0^\infty A^2\,dx = \int_0^\infty \frac{dx}{x^2+p^2} = \pi/2p$$

The ratio of this area to the maximum ordinate is used to define the average bandwidth of the square-of-the-gain curve, and could be interpreted as average bandwidth for two stages (whatever average bandwidth may mean). Thus the relative bandwidth, B = Area/Max. ordinate, or

$$(37)\quad B = \pi p/2 = W/f_o$$

converting from relative to absolute frequency.

$$(38)\quad \text{Actual Bandwidth} = W = \pi p f_o/2$$

This definition of bandwidth compares with the usual definition for a resonant circuit as follows:

$$(39)\quad W\ (\text{usual}) = p f_o/\sqrt{3}$$

which is the measured width of the resonance curve in cycles at 6 db down. Equation (38) defines bandwidth as the measured width of the resonant circuit at 5.4 db down.

This method of defining bandwidth will be extended to N pairs of staggered stages, as follows: Let S_N be the area under the square-of-the-gain curve for N pairs of circuits. Then:

$$(40)\quad S_N = G^{4N}\int_0^\infty \frac{dy}{[p^2+(s-y)^2]^N[p^2+(s+y)^2]^N}$$

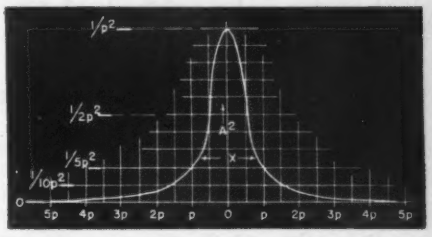


Fig. 6

This integral may be solved by the method of successive reduction[5] (see Appendix). The maximum ordinate of the square-of-the-gain curve is:

$$(41)\quad (A')^{2N} = G^{4N}/(2ps)^{2N}$$

TABLE I

N PAIRS	S_N	$B_N = S_N(2ps)^{2N}/G^{4N}$
1	$\frac{\pi G^4}{4p(p^2+s^2)}$	$\frac{\pi p s^2}{(p^2+s^2)}$
2	$\frac{\pi G^8(5p^2+s^2)}{32\,p^3(p^2+s^2)^3}$	$\frac{\pi\,ps^4(5p^2+s^2)}{2\,(p^2+s^2)^3}$
3	$\frac{3\pi\,G^{12}(21p^4+6s^2p^2+s^4)}{512\,p^5(p^2+s^2)^5}$	$\frac{3\pi p\,s^6(21p^4+6s^2p^2+s^4)}{8\,(p^2+s^2)^5}$
4	$\frac{\pi\,G^{16}(429\,p^6+143\,p^4s^2+39\,p^2s^4+15s^6)}{4096\,p^7\,(p^2+s^2)^7}$	$\frac{\pi p\,s^8(429p^6+143p^4s^2+39p^2s^4+15s^6)}{16\,(p^2+s^2)^7}$

(Make y=0 in (30) and use (31) to get A')

The ratio of (40) to (41) defines the differential bandwidth according to the definition given above for average bandwidth.

In Table I the values of S_N and B_N are given for one, two, three and four pairs of circuits. These values of B_N apply also to one, two, three or four double-tuned amplifier stages, since the only difference lies in the absolute level of amplification, which cancels out in the division of (40) by (41).

The relative bandwidth, B_N, has been plotted in Table II for various values of staggering (or coupling), s, in terms of power factor, p, for four values of N:

TABLE II

N Pairs of Circuits	Values of B_N for S =	
	p	$\sqrt{2}$ p
1	1.57p	2.07p
2	1.17p	1.83p
3	1.03p	1.43p
4	.96p	1.42p

An important fact is apparent from the last column in Table II, for moderate overcoupling, as exemplified by $s = \sqrt{2}\,p$: as the number of circuits increases, the relative bandwidth B approaches the value of B_o given in equation (23). This value of B_o is [from equations (14) and (23)]:

$$(42)\quad B_O = \sqrt{2}\,B' = \sqrt{2}\,\sqrt{s^2 - p^2}$$

$$= \sqrt{2}\,p \quad (\text{Since } s = \sqrt{2}\,p)$$

For larger values of N than are shown in the Table, B_N becomes constant at 1.41 p. For this reason, the value $B_o = \sqrt{2}B'$ could be chosen as a measure of bandwidth for any number of stages. The data of Table II constitutes a mathematical proof that it would greatly simplify broad-band amplifier discussion to define the bandwidth of overcoupled circuits (at least up to s (or k) = 2 p) as the width of the resonance curve at the center-frequency level of gain, as shown for B_o in Fig. 5. This width is the bandwidth of the equivalent amplitude frequency rectangle for 2N circuits, which number is the total number of circuits involved. It thus represents what could be called the **average bandwidth.**

Examples

Summary

1. Calculate p from the overall bandwidth specifications, and the number of stages chosen.
2. Choose D from Fig. 3, for the allowable departure per stage.
3. Calculate s (or k) from (19) and (20), i.e.,

$$s = \sqrt{(D+2)/D}\ p.$$

(Flatness expressed by D holds only over the relative band, B_o.)

4. Calculate the gain for N pairs of stages from equation (30) raised to the Nth power, setting y = O for center gain, and expressing y in terms of p for gain at other frequencies.

4a. Or, calculate the gain for N pairs of circuits from equation (13) raised to the Nth power, setting x = O for center gain, and expressing x in terms of p for gain at other frequencies.

Problem

It is required to build a broad-band amplifier with an overall maximum gain of 100 db and a bandwidth of 3 mc; the selectivity must be such that the gain is down 40 db at 3 mc to either side of resonance; and the overall departure from flatness must be less than ±1.5 db.

Choose the center frequency at approximately 20 to 30 mc (say f_o = 24 mc) in order that the differential bandwidth, power factor and coupling (or staggering), which are usually of the same order of magnitude, will not be too large a fraction of unity: $B_o = 3/24 = .125$. This is done so that the error, due to the symmetrical-analysis equations in Sections II and III, will be small.

In order to limit the number of tubes, choose a high-g_m type, such as the 6SG7, for which G is approximately (13$\mu\mu$f average c):

$$(43)\quad G = .005/(2\pi \times 24 \times 10^6)$$

$$(13 \times 10^{-12}) = 2.56$$

Assume that there will be three stages at least (as a trial) in order to get a trial value of D to determine the approximate gain per stage from equation (22). This trial value of D corresponds to 1.5/3 = 0.5 db in Figure 3: i.e., let D = 1.2, D' = 3.2, and calculate A_o from (22):

$$(44)\quad A_O = 2.56\sqrt{3.2}/0.125 \times 2.2$$

$$= 16.7 = 24.4 \text{ db/stage}$$

With this order of gain, it will require about four stages. Choose D = 2 (±0.25 db/stage, from Fig. 3, or ±1.0 db overall, which is within the design limits). Then:

$$(45)\quad A_O = 2.56 \times 2/0.125 \times 3$$

$$= 13.7 = 22.7 \text{ db/stage}$$

The overall gain will be 90.8 db which is 9.2 db short of the requirement. The use of grid damping only, on three stages, will make up for this deficit (at least 3 db/stage can be realized by this expedient).

Then, if double-tuned circuits are used throughout, the values of p and k are, from (18) and (19):

$$(46)\quad p = B_O\sqrt{2}/2 = 0.0875$$

$$(47)\quad k = B_O = 0.125 = \sqrt{2}\,p$$

From Fig. 2, however, the loss in gain per stage for the $k = \sqrt{2}p$ curve is only 9 db at twice the bandwidth (±3 mc off resonance: scale of abscissae is pf.=0.0875x24= 2.1 mc per division). Thus, the overall selectivity will be 4x9 = 36 db instead of 40 db as required at ±3 mc. It will be necessary, therefore, to use 5 stages of double-tuned circuits in order to meet the selectivity requirement. With a value of D = 2, the overall departure will be ±5 x 0.25 = ±1.25 db which is within the specs. Hence, p and k will be chosen still as given in (46) and (47). Both grid and plate damping can be used since the overall gain is easy of attainment with 5 amplifiers and 22.7 db gain/stage. The selectivity will be approximately 45 db at ±3 mc, which meets the specs. also.

The power factor of each circuit is adjusted by placing a parallel resistor across the coil (solve equations (1) and (46), simultaneously):

$$(48)\quad R_{||} = 1/pc\omega = 5870 \text{ ohms}$$

$$= 1/0.0875 \times 13 \times 10^{-12} \times 2\pi \times 24 \times 10^6$$

Had the selectivity requirement been less, say 6 mc at 20 db down, instead of at 40 db down, four of the amplifiers could have been of the staggered type and one of the double-tuned type, which would correspond to three pairs of circuits with $s = k = \sqrt{2}\,p$, and would give 3 x 9 = 27 db selectivity at 3 mc. The gain-constant would be only one-half the value given in (43), however, so that the overall gain would be down by a factor of $(1/2)^4 = 22$ db. It would be necessary in this case to use only two stages of staggered-amplification and to use grid damping on at least one of the double-tuned stages in order to bring up the gain.

(*Continued on page* 188)

Precision Interval Timer

Use of electronic principles permits exact timing control for production purposes despite line voltage fluctuation

• From among the many proposed developments that have been projected for the postwar electronic era, it is interesting to know of one item that has already been designed, tested, and tooled, and which has handled practical service in field operation under most rigorous and exacting conditions. It is of particular interest to professional and amateur photographers: a precision interval timer, using electronic principles, which overcomes the vagaries attendant upon the operation of mechanical and clockwork devices under certain conditions that are found in the field.

Half second intervals

The Richardson-Allen timer will control a 6.0 ampere lamp load over an exact interval from 0.5 to 30.5 seconds with an accuracy within 5 per cent of the indicated setting. Having no rotating parts, synchronous motors, or oscillating balance wheels, its accuracy is not affected by temperature, line voltage and frequency, altitude or humidity. The line voltage needed is nominally 115 volts, but voltages from 105-125 can be applied even if there is considerable frequency variation from the nominal 60-cycle value.

As shown in the photograph, the cumulative settings on the two dials give any operating interval up to 30 seconds, with an auxiliary half-second increment that can be added at will should the process require split-second operation.

The operating process is simple: the controlled device, such as a lamp or signal is plugged into a convenience outlet at the back of the timer cabinet. The timer itself is plugged into the power line. After setting the dials to the required interval, the actuating switch is depressed when the operation is to start, which turns on the load for the selected time. At the termination of the selected interval, the load is automatically turned off.

For production uses, as in photographic development, remote control as by a foot or printer platen switch is often necessary. This feature is also provided for through the use of a special control cable and socket at the rear of the cabinet. The reliability of operation, accuracy, and calibration stability are obtained by the incorporation in the design of components that have the required stability and by the use of a special circuit arrangement, which takes into account the numerous vagaries of electron tubes when used in precision circuits and avoids utilizing the characteristics that have non-repeatable actions.

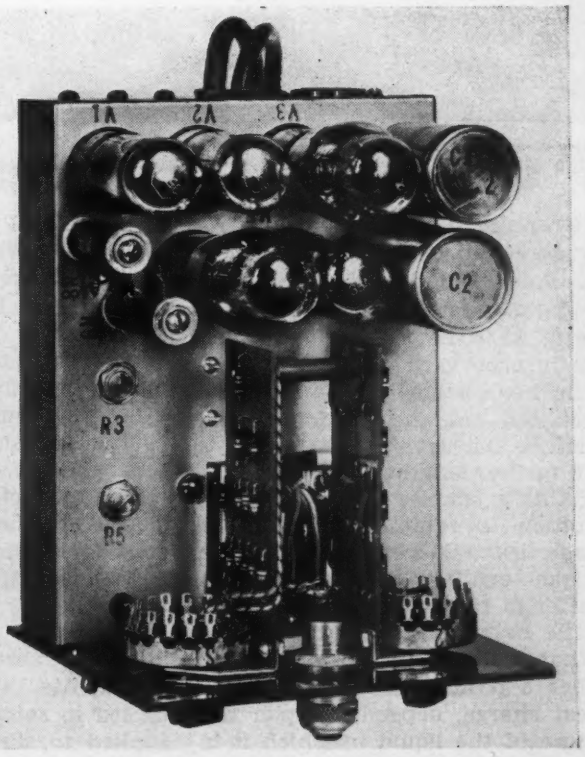
Tube line-up

A high-vacuum tube, actually a radio power-pentode (35-A-5) is used in the timing circuit to control a rugged type of relay capable of handling the load current. The thyratron type of timing circuit, so frequently used when any kind of interval determination must be produced, has been found to give unsatisfactory results when precise operation under various effects of temperature and other natural field operating conditions is considered.

An error of less than 5 per cent is obtainable after the tubes (which consist of two 35-Z-3, one 35-A-5, and two VR-150-30 tubes) are warmed up. However, if immediate

(*Continued on page* 184)

Electronic timer makes possible accurate selection of timing intervals up to 30.5 seconds varying by .5 seconds



Colloidal Graphite Films—P

by RAYMOND SZYMANOWITZ
Technical Director, Acheson Colloids Corp.
Port Huron, Michigan

Tungsten wire for vacuum tube filaments is drawn to size through diamond dies lubricated with colloidal graphite in RCA Harrison, N. J. plant

Uses for liquid graphite suspensions in electronic and allied industries

• Graphite, natural or synthetic, is an extremely versatile material and has found application in a wide range of industries. When of great purity, as is the case with the electric-furnace variety, its usefulness is further extended. When it is colloidalized and dispersed in liquid carriers, the list of applications is still further lengthened. The reason for this is simple; the graphite, in addition to retaining its original properties, takes on all of those unique qualities associated with matter in the colloidal state.

The first of these characteristics is that each minute particle carries either a positive or negative electrical charge, dependent upon the nature of the liquid in which it is dispersed and the type of ion it has adsorbed. When suspended in a liquid it seemingly defies the law of gravity. The particles do not settle out by virtue of their being kept in constant motion (Brownian movement) through bombardment by the molecules of the liquid and by the repulsion each particle suffers when it approaches a neighboring particle with its electrical charge of the same sign. While colloidal particles are not so small as those comprising materials in true solution, they possess, nevertheless, some of the properties of dissolved substances.

Graphite, when colloidally dispersed in suitable carriers, may be applied to surfaces to form, upon drying, continuous films which are opaque, unctuous, chemically inactive and electrically conductive. Such films are also low in photoelectric sensitivity, have a low coefficient of expansion, are good thermal conductors, have good "getter" properties and are effective absorbers and radiators of heat. All of these properties are utilized in the manufacture or operation of electronic devices.

Colloidalizing process

Late in 1906, Edward Goodrich Acheson—the father of both "Carborundum" and electric-furnace graphite—developed a process for colloidalizing graphite, a material which shortly thereafter was destined to make possible the drawing of tungsten into the fine filaments that now serve as the heart of hundreds of types of electronic tubes and incandescent lamps.

Efforts toward a process of developing ductile tungsten were seriously hampered, due to the lack of a suitable wire-drawing lubricant. When colloidal graphite in water (now marketed under the trade-

Properties of Colloidal Graphite and its Films

Hardness less than one (on the Moh scale)
Specific gravity about 2.25
Particles electrically charged
Diamagnetic
Co-dispersible with many liquids
Forms dry lubricating films which, in addition to having a low coefficient of expansion, are:
- **Opaque**
- **Chemically inactive**
- **Electrically conductive**
- **Good conductors of heat**
- **Effective thermal radiators**
- **Non-fusible**
- **Low in photoelectric sensitivity**
- **Capable of acting as gas absorbents**

mark "Aquadag") was brought out, trials were made which proved completely satisfactory, resulting in the worldwide adoption of this product as a lubricant for the diamond dies used in this art.

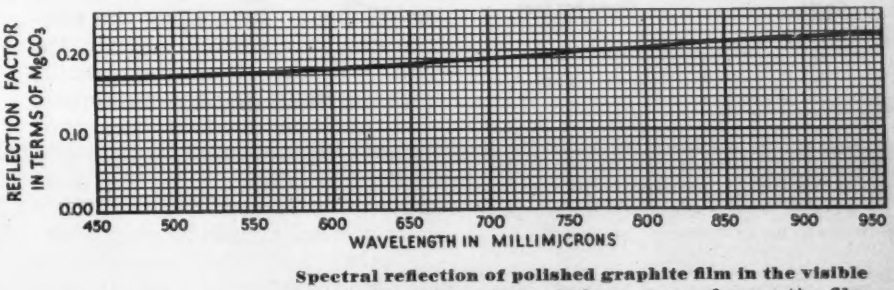
An aqueous dispersion of graphite applied to the tungsten bars during swaging and later to the coarse wire before the subsequent draws which it undergoes in the fabrication of filament stock, forms a tenacious, self-lubricating film which withstands the high temperatures necessary in the hot drawing of this metal. This film reduces die wear to a minimum and makes possible the uninterrupted production of wire of uniform diameter. The same technic applies to molybdenum.

Lubricating value

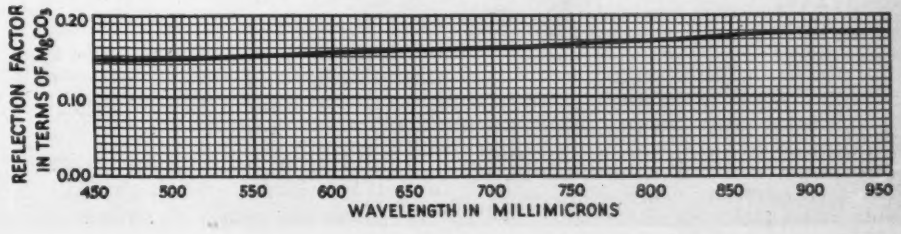
The lubricating and electrical properties of graphite are used in the manufacture of Pyrex suspension-type insulators employed on power lines. During the manufacture of these insulators, it was found that the metallic members tended to adhere to the glass portions. Inasmuch as it is important that a slight but definite movement occur between the glass and metal sections—to take care of differences in their rates of expansion and because mechanical movements are set up under the strain to which the insulator is subjected in use—the use of a lubricant is necessary. Oil was first tried but proved unsatisfactory as it had a tendency to volatilize under the heat generated when the insulator was assembled with molten alloy. In addition, the rupture of the oil film under high tension current promoted electrical failures. When a film of graphite formed with "Aquadag" was substituted for oil, a conducting dry lubricant was provided which eliminated both electrical and mechanical difficulties.

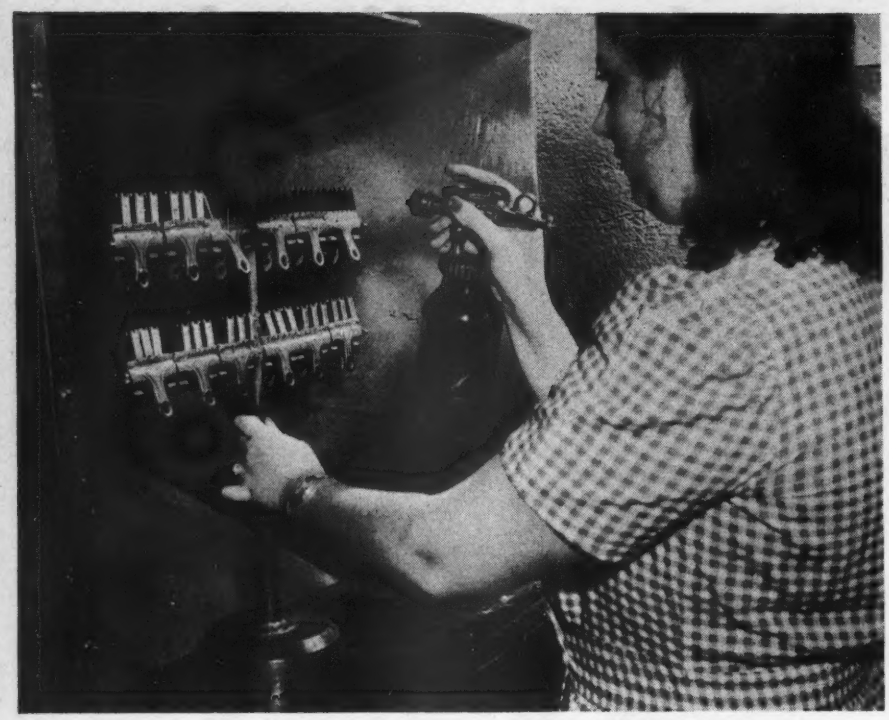
The lubricating ability of graphite is also used by manufacturers of radio receiving sets and related equipment. Colloidal graphite dispersed in either mineral oil or castor oil is applied to variable condensers, automatic tuning devices and other movable parts in broadcasting and receiving units.

Coating disks for copper-oxide rectifier cells with colloidal graphite improves efficiency by insuring intimate electrical contact, at Westinghouse, East Pittsburgh, Pa.



Spectral reflection of polished graphite film in the visible and infra-red regions. Below, curve for matte film





Graphiting tube anodes by spraying with suspension of graphite in water, at RCA tube plant

The role of graphite in electronics is not confined to its function as a lubricant. It is widely used in vacuum tube production for its other valuable properties.

Coats	Film thickness (inches)	Ohms per cm. sq.
1	0.6 x 10-4	1,900
2	0.75 x 10-4	1,180
3	10-4	660

Resistance of successive coats (on glass) of colloidal graphite diluted to 4.5 per cent solids content. Resistance of layer can be reduced up to 65 per cent by proper burnishing when dry or by heating (150-450 deg. C.)

Coats	Ohms per foot
1	27,000
2	400
3	110

Resistance of a capacity-coating on an asbestos braided cable; made with suspension having 9 per cent solids content by weight. Shows influence of absorbent substrata on resistance

Solids content weight	Ohms per inch square
3.6%	860
1.8%	4,500
0.9%	50,000

Influence of relative concentration on resistance. All above figures were supplied by E. G. Acheson, Ltd., and have not been confirmed. They are intended only as a guide

In the case of cathode ray tubes, for example, a graphite film formed with "Aquadag" is applied to the interior of the glass envelopes as an auxiliary anode, forming an opaque film which is equally adherent to all types of glass. Such coatings having a low coefficient-of-expansion, are amply conductive to function as anodes without the use of metallic substrata and during the baking of the envelopes acquire "getter" properties which maintain a high vacuum within a tube throughout its life. Films produced from colloidal graphite suspensions, in addition to providing opacity, possess a matte surface which reduces light reflection from the filament. By coating the electron gun in a similar manner, the light reflection from this usually bright metallic part is minimized.

In addition to this use, non-metallic electrodes have been improvised consisting of mica disks carrying graphite films. These electrodes are alleged to possess advantages over the conventional ones fabricated from metal in that they are not warped by heat treatment, give structural stability with low weight, contain no magnetizable material and have a resistance value great enough to prevent the setting-up of eddy currents.

Graphite coatings on mica also find utility in television transmitting tubes wherein they make up a part of the target or mosaic electrode. In this capacity use is made of the electrical-conducting and light-absorbing qualities of graphite.

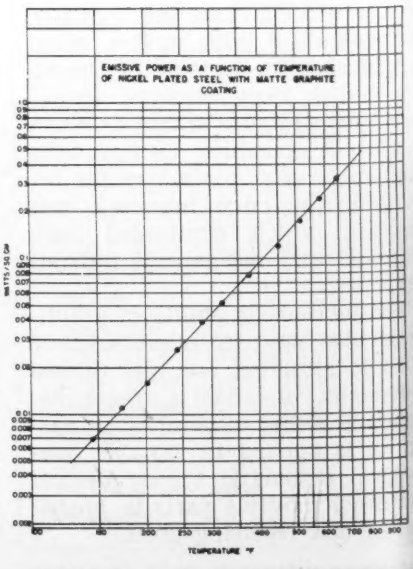
Minimizes thermionic emissions

In the manufacture of certain types of receiving and transmitting tubes it is customary to spray the grids with an aqueous dispersion of colloidal graphite. The procedure is to heat the parts in an oven to slightly above 100 deg. C. When the spray impinges upon them at this temperature, the water readily evaporates, leaving a lusterless deposit of graphite having good black-body characteristics. Metallic elements may also be graphited by plunging them while hot into dilute "Aquadag." The extent of heating and the dilution ratio are variables which must necessarily be altered with the mass of the object undergoing treatment and the thickness of coating desired.

The purpose of treating grids, and occasionally plates, in this manner is to minimize undesired thermionic emissions. Graphite may be applied directly to the relatively smooth metal, although more effective results are obtained if the tube part is first made rough by some process such as acid etching or sand blasting. Nickel-plated cold rolled steel which has been sand blasted and graphite coated possesses a heat energy radiation of the order of 0.3 watts per sq. cm.

Graphite films not only serve as good thermal radiators but are

(*Continued on page* 162)


EMISSIVE POWER AS A FUNCTION OF TEMPERATURE OF NICKEL PLATED STEEL WITH MATTE GRAPHITE COATING
WATTS / SQ. CM.
TEMPERATURE °F

Counting Radioactive Particles

by B. H. PORTER

Laboratory methods described for determining alpha-particle radiation emitted by radioactive substances

• The requirements of radiation chemistry, both in a laboratory and demonstration sense, necessitate a convenient alpha-radiation detector. Originated in 1912 by Geiger and Rutherford, this type of device has undergone numerous transformations and improvements during the intervening years. The following discussion is intended to describe the salient features of such a refined, automatic, counting model adapted for physio-chemical use.

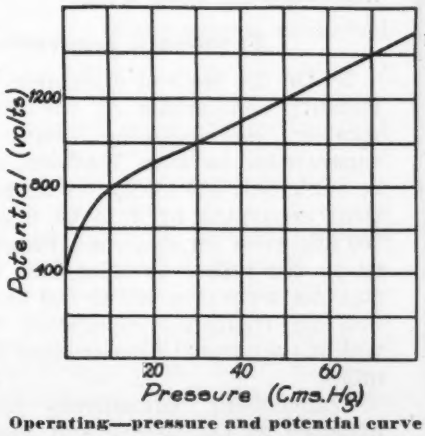
The electrical system shown, consists of three major units, chamber, amplifier and the thyratron counting control. It will be noted from the accompanying key list of parts that this circuit contains nothing but standard items.

The ionic charge collected by a fine tungsten point, after the entry of a particle from the radioactive source into the ionization chamber, produces a potential variation at the point electrode and hence a change in potential at the grid of the first tube.

Impulse recorder

The voltage impulse is amplified with as little distortion as possible by the two-stage amplifier, until the anode current surge from the last tube is of the order of several tenths of a volt. This impulse applied to the grid of the first thyratron, which has been critically adjusted above the background of hum of outside disturbances, causes its discharge. The anode current of the thyratron itself is limited to just sufficient strength to move the armature of an automatic recorder. With the thyratrons alternately glowing at each discharge, the counter registers every other alpha particle entering the chamber. High frequency disturbances from induction coils or similar apparatus are minimized by shielding the entire amplifier and chamber units with copper screen. Non-conducting parts of wood or glass are preferably painted with a solution containing one part of concentrated colloidal graphite and two of water. The thyratron unit, moreover, is separated from the adjoining systems by a suitable distance on either side.

Counting chamber in which electrical impulses are amplified and made to operate an automatic recorder



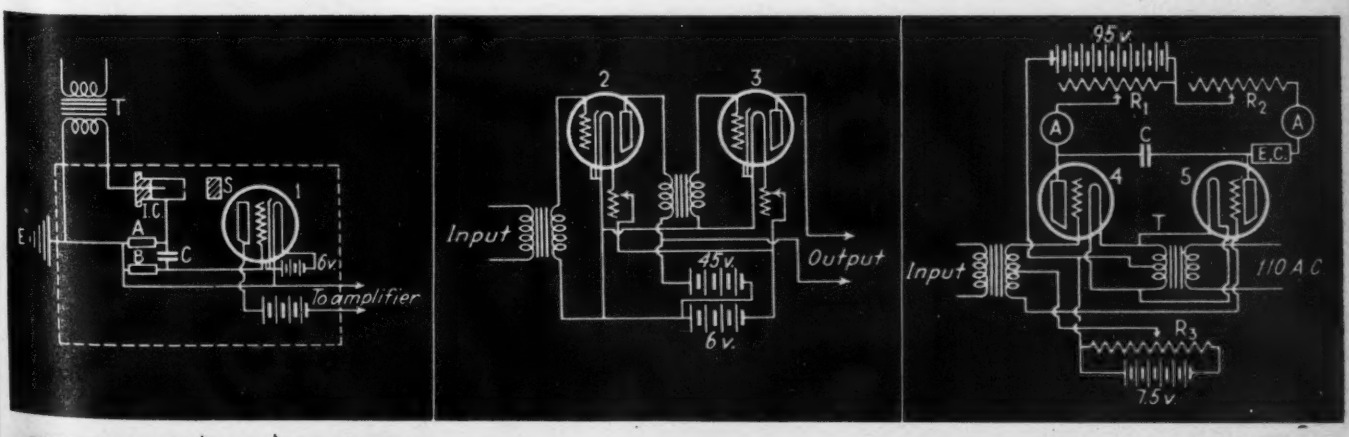
Operating—pressure and potential curve

The preparation and care of the point electrodes for the ionization chamber are the chief source of trouble. Tungsten is best adapted as a collector because it restores itself with fewer heating and cleaning treatments and can operate continuously for intervals from three to five hours. With alternate periods of rest and operation, such electrodes will operate satisfactorily from two to three weeks and, upon being found useless, can be reground. They will, moreover, operate consistently well as the impressed voltages are decreased with changes in atmospheric pressure.

Pieces of tungsten wire (0.78 mm diameter) are ground on a lathe to a fairly true point with a No. 4 India stone and to about 3.0 mm back from one end. A hard Arkan-

(*Continued on page* 160)

Chamber unit **Amplifier unit** **Thyratron unit**



AIRPORT Control with UHF

by H. C. HURLEY*
Technical Development Division
Civil Aeronautics Administration

Tests indicate power needed for reliable communication over 30 mile radius and frequency separation required

• In order to give impetus to the development and production of suitable ultra-high frequency equipment and to determine the frequency separation required in concentrated areas, three transmitting equipments and six aircraft receivers were purchased. On the basis of the results obtained during this investigation, it is concluded that:

1. An airport traffic control transmitting system greatly superior to the present low frequency system has been realized by the application of ultra-high frequencies to this service.

2. A reliable service range greater than 30 miles radius at an altitude of 1,000 feet will be obtained.

3. An automatic volume control in the receiver will smooth out the signal variations caused by high angle lobes.

4. A transmitter delivering 100 watts of power to a crossed dipole antenna erected 50 to 90 feet above ground level will provide sufficient signal strength at 30 miles and 1,000 feet altitude so that service may be rendered to all types of aircraft even though there may be high inherent noise levels.

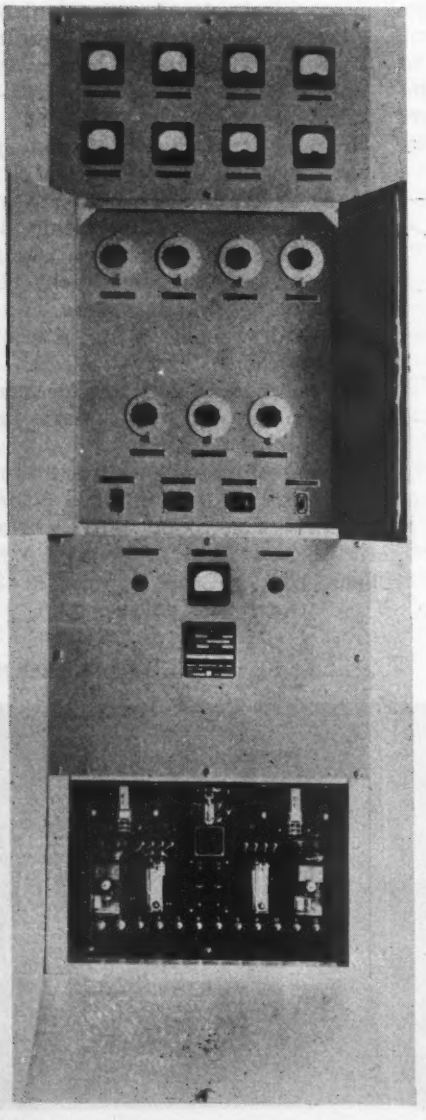
Frequency separations

5. On the basis of a receiver selectivity comparable to the RUH receiver, the following frequency separations between stations will be sufficient: 200 kilocycles for stations separated by 0 to 60 miles; 100 kilocycles for stations separated 60 to 200 miles; 15 kilocycles for stations separated 200 to 500 miles and no frequency separation for stations separated greater than 500 miles.

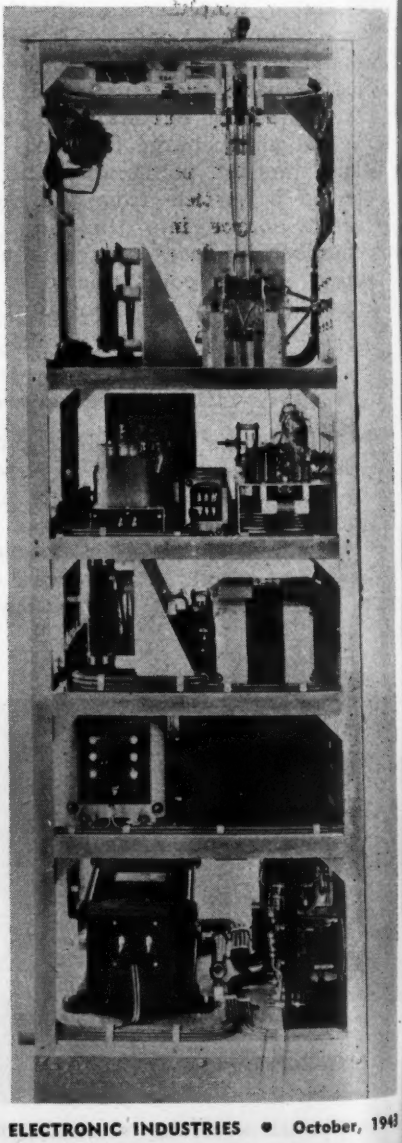
Transmitting equipments were installed at LaGuardia and Floyd Bennett airports in New York City and the Municipal airport in Philadelphia. Aircraft receivers were installed in the Stinson airplane NC80, comprising a type RUH receiver, a 5 milliampere recorder and a special filter-control unit, and in the Boeing airplane NC-11. The Stinson was used for conducting test flights and the Boeing for demonstration flights.

The transmitter is crystal controlled and is capable of delivering 100 watts output at 129 to 132 megacycles. The crystal frequency is one twenty-fourth of the transmitting frequency. The coupling circuit connects to a balanced two-wire transmission line which feeds the antenna. Two capacitive pick-up circuits are provided at the input to the transmission line and are used as a check of the input voltage to the line, and also give an indication of the modulation percentage.

100 watt crystal-controlled transmitter — front view



Side view of 100 watt crystal-controlled transmitter



*From a paper before the Washington Section, Institute of Radio Engineers

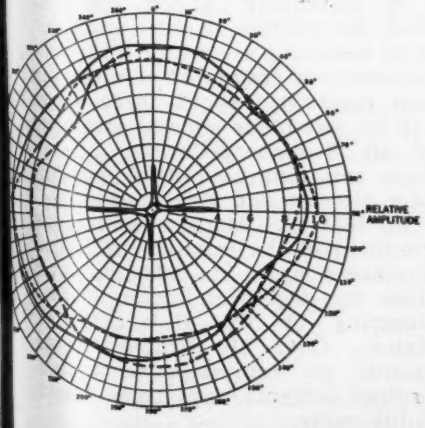
The transmitting antenna is designed to radiate a horizontally polarized signal having an essentially circular field pattern in the horizontal plane. The 90 degree phase shift required between the two folded dipoles is obtained by making one unit shorter than one-half wavelength and the other longer than one-half wavelength.

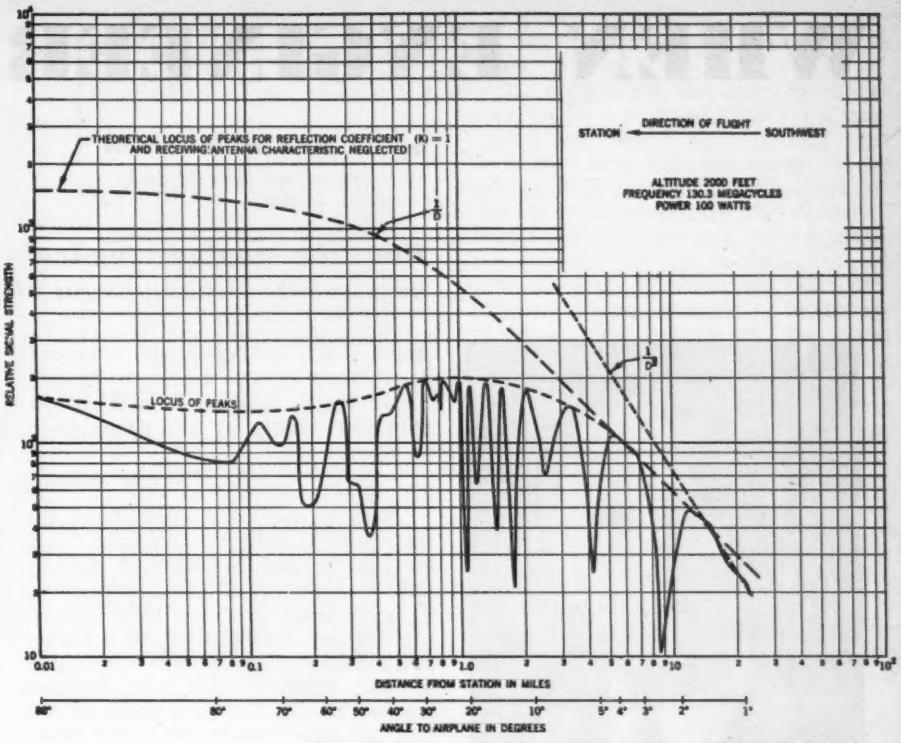
A sleeve type construction of the folded section provides for adjusting the lengths of the dipoles and when properly adjusted for the frequency used, the shorter unit is capacitive and draws current that is leading the feeder voltage by 45 degrees, while the longer unit is inductive and draws current that is lagging the feeder voltage by 45 degrees. A small inductance coil is used to tune out the stray shunt capacity of the feed through insulators.

A quarter wave transmission line section having an impedance of 205 ohms is used to match the antenna which has an impedance of 300 ohms to the 140 ohm transmission line. Measurement of the horizontal field pattern of the antenna was made prior to its installation at the airport. The antenna and measuring equipment was set up at a location where the ground was level and free of obstructions for a distance of over 1,000 feet. Patterns were obtained at three frequencies as indicated. Prior to the measurements, the antenna elements were adjusted for 130.3 megacycle operation and this adjustment was used for all three measurements.

The aircraft receiver used in these tests employs a double superheterodyne circuit and is designed for general application of both voice and radio range reception. It is capable of tuning the two frequency bands 60-66 megacycles and 123 to 132 megacycles. In addition, crystal-controlled spot frequencies are provided for operation at 125 and 130.3 megacycles.

Field pattern produced by the antenna on the ground at 100 feet distance




THEORETICAL LOCUS OF PEAKS FOR REFLECTION COEFFICIENT (K) = 1 AND RECEIVING ANTENNA CHARACTERISTIC NEGLECTED
STATION
DIRECTION OF FLIGHT
SOUTHWEST
ALTITUDE 2000 FEET
FREQUENCY 130.3 MEGACYCLES
POWER 100 WATTS
LOCUS OF PEAKS
RELATIVE SIGNAL STRENGTH
DISTANCE FROM STATION IN MILES
ANGLE TO AIRPLANE IN DEGREES

Recording of signals received from Floyd Bennett field during a flight at a constant altitude of 2000 feet

Phenomena observed

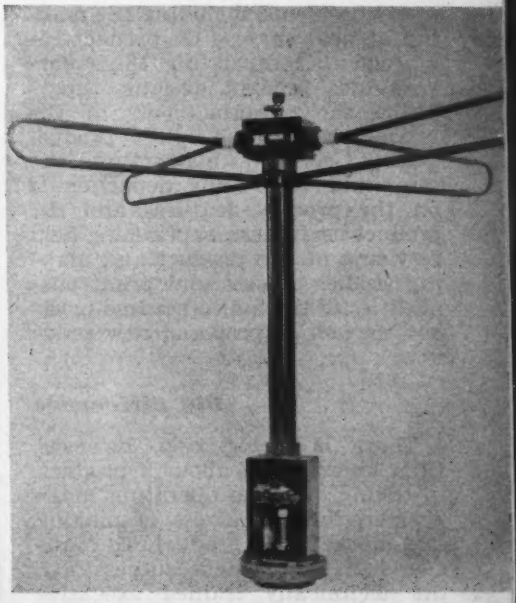
The selectivity characteristic of the receiver if system is an important factor when conducting tests to determine the allowable frequency separation between transmitting stations. At 100 kilocycles off resonance the attenuation is 36 db and at 150 kilocycles, 60 db.

The phenomena particularly observed in testing were: transmitting and receiving field patterns, interference at various frequencies, propagation, and service range. Since the operation of airport traffic control transmitting equipment is normally for intermittent voice transmission, it was necessary to provide a different method of operation in order that measurements of the transmitting characteristics could be made. To accomplish this, each transmitter was provided with an audio oscillator and arranged for continuous operation whenever required. The frequencies of the tone signals were 1,020 cycles for the Floyd Bennett station, 460 cycles for the Philadelphia station, and 4,300 cycles for the LaGuardia station. The transmitters were modulated approximately 90 per cent.

In order that full consideration could be given to the effect of the receiving antenna characteristics, flight tests were conducted to obtain this information. This was derived from recordings made during flights at points located 20 to 25 miles from the transmitting station and at altitudes of 1,500 to 2,000 feet. The receiver was operated on manual volume control for these tests. A graph shows the horizontal pattern obtained when

(*Continued on page* 168)

Horizontally polarized crossed dipole antenna



WHEN ENGINEER IS BOSS

by DR. RAY H. MANSON
Vice-President and General Manager
Stromberg-Carlson Co.

How the engineering-trained executive can best tackle management thinking and action

DR. RAY H. MANSON

● The management of many manufacturing plants has, in recent years, been turned over to engineering-trained men. The main reason for this is that the majority of management problems in these institutions are technical in nature. This is particularly true of the electrical and communications industries, in which manufactured products, from their inception to their end use, are of a highly technical nature.

For example, in the radio industry, we find engineers handling many problems, including the making of field surveys on product requirements, translating these surveys into product designs, supervising the manufacturing of the product, handling the product quality control, instructing the sales and advertising departments on the product features and the product usefulness, supervising field servicing of the product and making studies of cost and profit possibilities of the manufactured product, as well as proposed new products.

Big difference

There is a big step, however, from knowing all about a product, to taking over the operating management of a business of making and marketing a product. To manage such a business successfully, the technically trained executive must learn to handle the overall operations of the business from a broad-gage viewpoint and to do this with efficiency and dispatch.

Forget details

To most engineers, who, from the nature of their training, are steeped in the handling of details, this is a very difficult assignment. It is imperative that the engineering-trained executive have a clear-cut picture of all of the operations of the business and not be distracted or blinded by a maze of detail; in other words, he must learn to see and appreciate the beauties of the forest, rather than that of the individual trees.

This means the proper assigning of work to others, in order that the necessary details will be handled promptly and correctly and that there be complete coordination of effort to the common end of making the desired quality of product, at the time scheduled and with a profitable return to the owners of the business.

Outside contacts

Besides handling internal problems of the business, the engineering-trained executive must look for much outside help, such as can be obtained from memberships in national, manufacturing and trade organizations. It is not enough to confine these outside contacts to the particular type of business immediately of interest, as the study of other industries often provides ideas which can be used to advantage.

In addition to running the internal affairs of the business, the engineering-trained executive will find it advisable and, in many cases, necessary to do an intelligent job of reporting on internal operations of the company to directors, stockholders and to an interested public.

Delegate authority

All of this can be summed up briefly in the statement that the engineering-trained executive must get away from needless details, delegate necessary authority to others, obtain organization teamwork, set reasonable performance schedules, get work done right and on time, plan adequately for the future and, at all times, make a reasonable profit in the overall operations of the business.

SEVEN REMINDERS
for the
ENGINEERING EXECUTIVE

- Get away from needless details
- Delegate authority to others
- Obtain organization team work
- Set performance schedules
- Get work done right, and on time
- Make a reasonable profit
- Plan adequately for future

About Dr. Manson

Dr. Manson has been continuously engaged in the communications business since graduation from the University of Maine in 1898, first with the Western Electric Co., Chicago, then with the Kellogg Switchboard & Supply Co., also of Chicago, later with the Dean Electric Co. and its successor, the Garford Mfg. Co., both of Elyria, Ohio, and since 1916, with the Stromberg-Carlson Co., Rochester, N. Y.

In Stromberg-Carlson, he first held the position of chief engineer, later becoming a director and vice-president in charge of engineering and research. About three years ago he was made general manager of all Stromberg-Carlson operations, retaining his official position as a director and vice-president.

In 1931 Dr. Manson served as president of the Institute of Radio Engineers and, in 1933, he was given the degree of Doctor of Engineering by the University of Maine. Over 110 United States patents on communications and kindred subjects have been issued in his name.

Field strength indicator and two styles of pickup units for measuring residual field of a part (upper) and field strength (lower)

Measuring Magnetic Fields

Low intensity fields are rapidly analyzed by electronic indicator combined with magnetic bridge

• When electron tubes are incorporated into any kind of job that previously was accomplished by very sensitive mechanical setups, there is always the likelihood that the job is done better and that additional features are introduced as well. The direction of magnetic fields has long been traced by delicately-balanced compass needles swinging on jewelled bearings. There was little possibility of accurate measurement of magnetic intensity, however, by this method, other than by noting apparent changes in the field and computing the effect of whatever caused the distortion.

Compass installations

When a navigational compass is installed in any new location it is necessary to check the divergence and to compensate for, or eliminate the cause. For these checks the Waugh Magnetometer is designed for use in determining the magnetic fields produced by residual magnetism in materials, members and parts. When residual magnetism in parts or members causes undesirable effects, the magnetometer may be used to measure its direction and its strength. It is particularly important that parts which are to be built into aircraft be free from residual magnetism in order to prevent its affecting the compass in the plane.

It is convenient to measure the magnitude of the field strength due to residual magnetism in milligauss and in degrees deflection the error that field would produce on a compass.

Intensity and polarity

The instrument shown is comprised of two pieces of equipment: (A) the indicating unit consisting of a stabilized, low-gain amplifier and an electronic bridge for indicating field strength and polarity; (B) the pickup unit which supplies the controlling signal to the indicating unit. Sufficient sensitivity is built into the Magnetometer to permit adjusting the instrument to a full scale reading of three degrees where there is a strong horizontal component to the earth's field. In higher magnetic latitudes, however, and where the earth's field is distorted by local magnetic fields, it may not be possible to calibrate it to this degree of sensitivity. One of the lower values of sensitivity should therefore be used.

In measuring the residual magnetism in a piece of structural material the bench type pickup unit is used and the specimen to be checked is placed near it. The indicating is automatic and continuous in that there are no magnetic or electric circuits to balance. In the analysis of compass field distortion in an aircraft a different type of pickup unit will be found to simplify the test. It permits an easily trained operator to accurately determine the null position and polarity on a protractor scale, readable to 3′ of a degree of an arc. It has a direct reading scale, requiring no calibration chart, with a multiplier scale in convenient units for range extension.

The earth's field (horizontal component) may vary between 100 and 400 milligauss so that full-scale deflections on the three ranges of 30, 300 and 900 milligauss cover the range adequately.

In operation this unit is "sighted" along the magnetic field. With the multiplier switch at "10," the knob on the pickup unit is turned until the 0 deg.-180 deg. line is aligned with the two peep sights, with the 0 at the witness point. The entire case is rotated until the meter needle on the indicating unit reads "zero." The 0 deg.-180 deg. line determined by the scale on the pickup unit now indicates the true magnetic north and south line. This position may be more accurately determined by turning the "multiplier" switch to the "I" position and adjusting the meter needle more accurately to "zero" position.

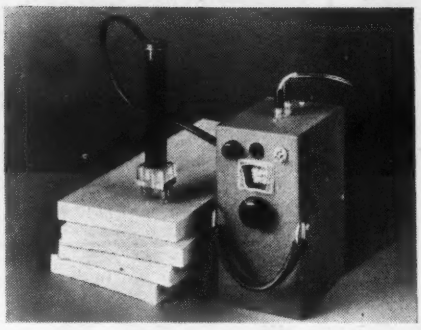
True north adjustment

Final adjustment of the sights along a true magnetic line may be accomplished by loosening thumb screw F and rotating the sight arm so that the witness point on the sight arm is exactly opposite the "zero" on the dial, tightening thumb screw F. This sight arm may be adjusted over approximately an eight degree range. After the witness point on the sight arm has been brought opposite the "zero," sights may be raised and used for sighting a true magnetic north and south line.

Electronic Tubes on the JOB

Amplifier Tests Soundness of Castings

A microphone-amplifier combination now tests the soundness of castings and forgings. When the piece is struck with a hammer, it rings, a microphone amplifies this sound and filters out harmonic frequencies so that the base frequency may be compared with a standard tone. A defective part will not vibrate as a good part does, just as cracked bells do not ring as whole ones do.



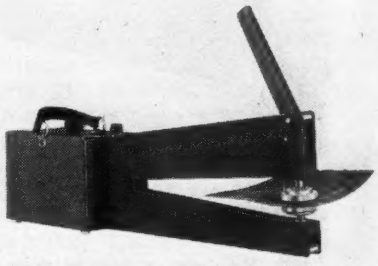
Method of electronically determining moisture content of wood using spiked instrument which is hammered in

Moisture Detector

The Delmhorst moisture detector manufactured by the Measurements Corp., Boonton, N. J., tests plaster, masonry, or wood, and shows when these materials are in the proper condition for the application of paint, wall paper, acoustic tile or other decoration. Wood parts should be manufactured at a moisture content equal to that which they will eventually attain in permanent use.

The Model 5M moisture detector equipped with Model 4E four pin electrode measures moisture content of wood from 8 to 24 per cent. Special electrodes are available with the contact needles affixed to the hammer head so that contact with the wood is made with one hand in a single hammer blow.

In the Model 5E veneer electrode shown, the toggle lever is depressed and the sheet inserted between the electrode discs. The lever is then raised and the dial knob is turned until the indicator lamp flashes on. The moisture content is read on the dial directly in percentage. The Model 5M moisture detector, when used with the 4 pin electrode, is calibrated to read directly moisture content in Douglas fir. When used with the electrode for veneers, it is necessary to apply a correction shown in a table furnished with the electrode. No calculation is required as it is only necessary to read the number shown in the table opposite the dial reading for the species and thickness being tested.



With this type of equipment, detector measures moisture in sheet materials

These instruments use, in addition to the neon glow lamps, one type 1N5-GT pentode and two "A" batteries and two "B" batteries.

One of fifteen specially constructed and equipped communications trucks built for U.S. Coast Guard which serve various government bureaus for emergency radio work

Communications Trucks

The U. S. Coast Guard now has fifteen "communications trucks," portable radio stations developed for use in disasters such as floods, tornadoes, or tidal waves. One of these trucks has frequently been the only contact with the outside world for many days. Used inland as well as on the coast, they have worked for Army, Navy, and FCC as well as for the Coast Guard. Photo shows U.S.C.G. radiomen reeling out antenna for attachment to any convenient high object.

High Speed Flash Unit

For high-speed photographic analysis of mechanical speeds in the neighborhood of 2,000 ft. per second, General Electric's general engineering laboratory has produced a new flash unit giving an illumination photographically equal, to over 1,000,000 foot-candles with a duration of but 4.0 micro-seconds. The rate of discharge of current through the lamp that is used in

the order of 4,000,000 watts, but due to the short duration of the flash the high momentary current does not cause serious heating. The entire assembly is contained in a case 9 by 9 by 10 in. and weighs about 20 lb.

Three types available

Three types of synchronizing units are available. The first type is a phototube pickup unit which is so arranged that the lamp may be tripped either by cutting off a light beam falling on the cell, or by turning on a light beam directed at the cell. The second type consists of a very small mechanical contactor actuated by a diaphragm. This type of assembly replaces the need for a microphone and its separate necessary amplifiers. The third type of synchronizer consists merely of two wires connected to the object being photographed in such a way that, at the moment it is desired to take a picture, contact between the two wires is either made or broken. The lamp can be made to trip under either condition. With these varied forms of synchronization available, practically any type of synchronizing procedure may be used—specifically, making or breaking a light beam, tripping by the impact of a sound or other compression wave, and by making or breaking a simple electrical contact.

Circuit of unit

The circuit of this flash unit consists essentially of a capacitor which stores up energy and a switching arrangement which releases this energy to be discharged through the lamp. The lamp is of the high-pressure mercury vapor type.

Either of the following basic methods can be used to flash the lamp: first, through a switch placed directly in the discharge circuit which completes a metallic circuit between the capacitors and the lamp; and second, by the use of a thyratron acting as a switch. In the second method the switching circuit controls the grid of the thyratron, which in turn controls the current through the lamp. With this method, flashing control is obtained in a 2000-volt circuit by the switching of a 35-volt circuit at low current value.

In the present equipment the lamp may be flashed approximately once every 5 seconds at about 95 per cent of its maximum intensity. However, it may be flashed approximately twice per second at a lower intensity. This lower intensity is ample for visual examination of a moving body, but it is not sufficient for photographic purposes.

The life of the lamp is not known. However it is a matter of record that one lamp was flashed 330,000 times in the laboratory at a rate of one flash every 5 seconds, and at the end of this test was still in good operating condition.

It is also worthy of note that this run was completed with the use of a single thyratron. It is safe to state that the life of this lamp is probably 1 second or more, since the total additive time of the 330,000 flashes approximates 1 second.

Stroboscope Tests Fuses

Three engineers of the Elgin National Watch Co., Elgin, Ill., have been awarded War Production Board recognition for the development of an entirely new method for checking the accuracy of fuses used in anti-aircraft shells to detonate the charge "upstairs."

An integral part of the checking process is an electronic stroboscopic unit. Mr. Ensign is shown operating a General Radio "Strobotac."

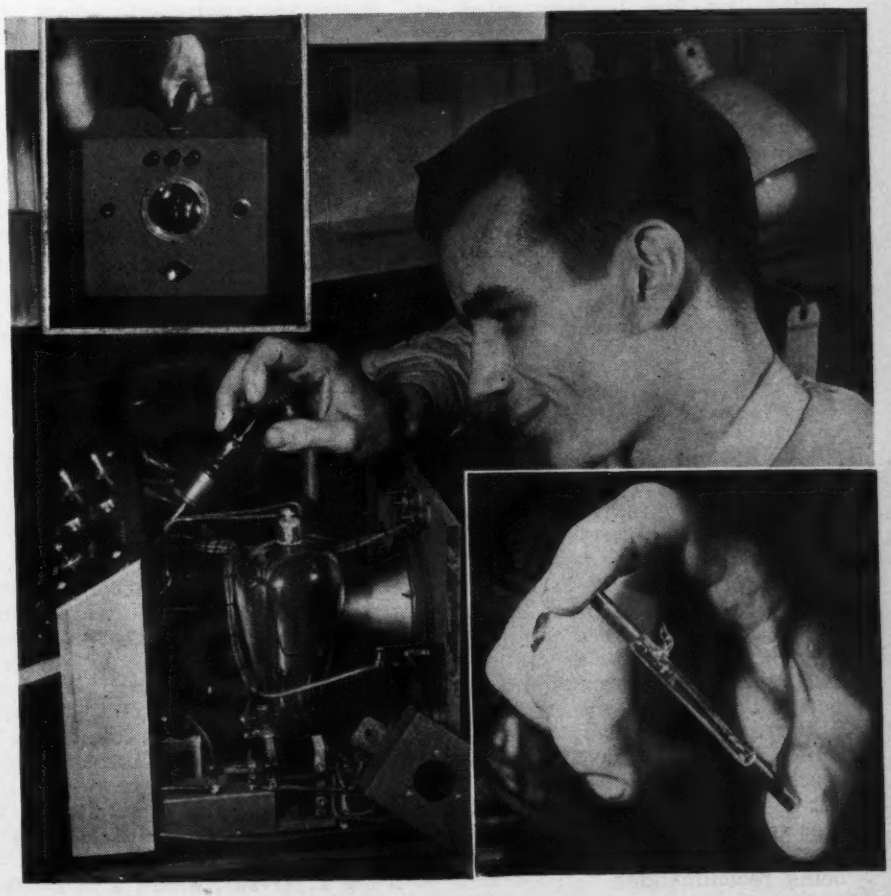
Dr. Carl N. Challacombe, George G. Ensign and Walter Kohlhagen are credited with developing a revolutionary theory of hairspring behavior through study of the "watchwork" timing devices. The

Fuse firing characteristics are predicted within .01 sec. with new Strobotac method

fuses' firing characteristics can now be predicted to 1/100th second accuracy at any pre-set point between 3 and 25 seconds.

Details of the new fuse timing system are classified, but a complete technical description is on file with the Navy Department's Bureau of Ordnance for the use of qualified manufacturers of mechanical time fuses.

High-speed flash unit gives light photographically equivalent to 1,000,000 foot candles. Tube handles discharge current at rate of 4 million watts



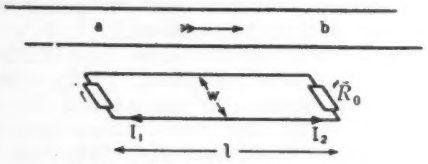
SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Measuring Reflection in Feeders

Pistolkors and Neumann (Elektrosvyaz, No. 4, Vol. IX, reported in Wireless Engineer, London, August, 1943)

If a feeder is not correctly matched at its termination, a backward traveling or reflected wave of amplitude V_b is superposed upon the forward traveling wave of amplitude V_f. The ratio V_b/V_f can be measured directly by the device described.



Measuring feeder reflection

It is shown that for a wave traveling from left to right the current I_2 in the right-hand end of a lossless transmission line is zero, provided the line is terminated at both ends by its characteristic impedance R_o and is arranged parallel to the feeder a—b. Similarly, a wave traveling from right to left produces no current I_1 at the left-hand end of the transmission line. The currents I_1, I_2 in the two terminating resistances will therefore be indicative of the forward and backward traveling waves, respectively, and by comparing these currents, a measure for the ratio of the two wave intensities is obtained.

On Piezo-Electric Crystals

(Bell System Technical Journal, July, 1943)

The issue contains three articles on piezo-electric crystals.

"A mineral survey for piezo-electric materials," by W. L. Bond, reports a systematic investigation of all crystals expected to show piezo-electric characteristics. Seventeen different crystals were found to be active. However, some of them are not readily available, others are difficult to handle because of their mechanical properties or do not occur in suitable crystals. For these reasons quartz is stated to be the most important, tourmaline also being recommended.

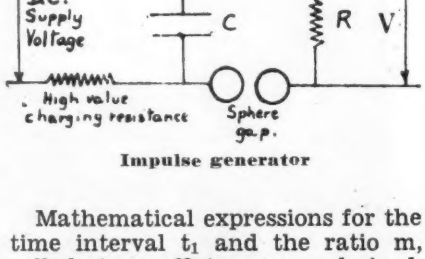
"Quartz crystal applications" by W. P. Mason describes the inner molecular movements explaining piezo-electric effects, and compares the properties of different crystal cuts. In an appendix, mathematical relations between stresses, strains, polarization and electric fields in crystals are treated and the results discussed.

In another article by W. L. Bond, methods for specifying quartz crystal orientation are given, the behavior of light passing through crystals is described, and optical means to determine the orientation of an individual piece of crystal are explained.

Efficiency of an Impulse Generator

G. H. Rawcliffe (Philosophical Magazine, London, May, 1943)

If no inductance were present in the impulse generator shown in the diagram, the voltage would rise to its peak value as soon as the condenser is connected across discharge resistance R, and then decay exponentially to zero. Through the influence of the inductance, the peak voltage on the discharge resistor takes a finite time interval t_1 to develop, and the value of the peak voltage is less than the condenser charging voltage; the ratio of the condenser charging voltage to the peak voltage will be denoted by m.



Impulse generator

Mathematical expressions for the time interval t_1 and the ratio m, called stage efficiency, are derived. These formulas being rather involved, approximations based on the assumption that R^2 is much smaller than 4L/C are found. As L is usually very small, the condition is met in practical cases. It is shown that the time interval t_1 is approximately equal to $[L \log (1/a)]/R$ and stage efficiency m to $(1-a + a \log a)/(1-2a)$, where $a = L/CR^2$.

Investigation of the approximate expression (CR log 2) for the time interval t_2 within which the peak voltage drops to half its initial value shows that for most practical cases the expression is a sufficiently good approximation. However, a more accurate value may be obtained by adding $[-t_1 + CR(1-m)]$.

High Energy Electron Tube

H. O. Wykoff and J. E. Henderson (Physical Review, July, 1943)

A special electron tube was used in the course of investigating the properties of the visible radiation, described in 1934 by P. A. Cerenkov, when high speed electrons traverse transparent media.

The tube was required to produce a well-collimated, high-energy electron beam. It was designed for operation at potentials up to 800 kv, and consisted of four sections to which the voltage was applied in successive steps of up to 200 kv each. Filament and grid were made adjustable vertically by means of syphons and adjusting nuts without breaking the vacuum. A double eccentric permitted lateral adjustment of the filament with an amplitude of about 1 cm in every direction from the axis. Structure, focusing and operation of the tube are discussed in detail.

Direction Finder for Atmospheric Disturbances

G. Nobile (Bulletin des Schweizer Elektrotechnischen Vereins, Basle, Jan. 27, 1943)

The device is said to indicate in Switzerland thunderstorms occurring on the Atlantic coast of the United States, even though there are, simultaneously, heavy storms in Switzerland. It is essential to exclude disturbances by telegraphic and radio transmitters, and high selectivity of the receiver, tuned to 11,000 m, is therefore required.

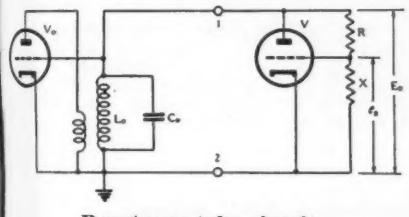
The apparatus includes two loop antennas mounted at right angles to one another and connected to two amplifiers, respectively. One of these amplifiers is blocked by the output of the other, unless the

corresponding antenna is within several degrees at right angle to the direction of disturbance. The first amplifier actuates a stylus which writes on a paper rotating together with both antennas at the speed of one revolution per minute.

Reactance-Tube Network

H. A. Ross and B. Sandel (A. W. A. Technical Review, Sydney, Vol. 6, No. 2, 1943)

In the reactance-tube circuit shown, the oscillator frequency f depends on the equivalent impedance Z_o of reactance tube V which impedance is a function of the mutual conductance G of the tube. By varying the grid potential e_o in accordance with a signal voltage E_o, the mutual conductance G is varied and the oscillator frequency



Reactance-tube circuit

made a function of the applied signal voltage. Mathematical expressions for the sensitivity, i.e. the variation of oscillator frequency with mutual conductance, $\left(\frac{df}{dG}\right)$, are derived. The second step to be considered, i.e. the change in mutual conductance with grid voltage $\left(\frac{dG}{de_o}\right)$ is a tube property and generally available; it is a constant if the reactance tube is operated in the linear range of the G-e_o characteristic.

It is assumed that $R \gg X$, $R \gg Z_o$, and that changes in plate current are proportional to the grid voltage e_o. By a simple computation, the equivalent tube impedance Z_o is shown to be $-jR/XG$, this is a capacitance equal to GL/R if X is an inductive reactance L, and it is an inductance equal to CR/G if X is a capacitive reactance C. The sensitivity of the system

$$\frac{df}{dG} = \frac{L}{R}\,\frac{f^3}{2C_o f_o^2} \quad \text{or} \quad \frac{1}{CR}\,\frac{L_o f_o^2}{2f}$$

, for X an inductance L or capacitance C, respectively; f_o being the oscillator frequency for minimum mutual conductance.

A series of tests to confirm the expressions obtained for the sensitivity were carried out, and its linear dependency on L/R or on 1/CR was established. Selection of the circuit constants may be based on these relations to meet particular requirements. Other effects influencing the frequency - mutual conductance characteristic are explained.

Wide-Range Oscillator

T. A. Ledward (Wireless World, London, September, 1943)

The resistance-coupled multivibrator circuit shown operates from 16 to 18,000 cycles with nearly constant amplitude, the three ranges covered by the three positions of ganged switches A and B being 16 to 300, 250 to 3,500 and 1,200 to 18,000 cycles.

The feedback path consists of the two equal condensers C_1 and C_2 (C) and the two equal resistors R_1 and R_2 (R). R_2 is inserted between C_2 and ground, R_1 connects a tap on R_2 with the grid of the first multivibrator tube V1.

It is shown that, provided the oscillation frequency f equal to $1/2\pi CR$, is varied by simultaneously varying ganged condensers C_1 and C_2 so as to maintain their capacitance equal, their reactance will be equal to resistance R for any oscillation frequency. Further, for constant R, the oscillation amplitude is independent of frequency.

Potentiometers P_1, P_2, P_3 control the amplitude for the three ranges; they are set by trial to give the same amplitude for each range. Trimming condenser C_T is included to make up for the effective grid capacitance of V1 in parallel with C_1. The diode section of V1 is intended to lock any multiple of the mains frequency if the oscillation frequency is adjusted to be very close to a harmonic of the mains frequency.

Short-Wave Reflection on Ionosphere

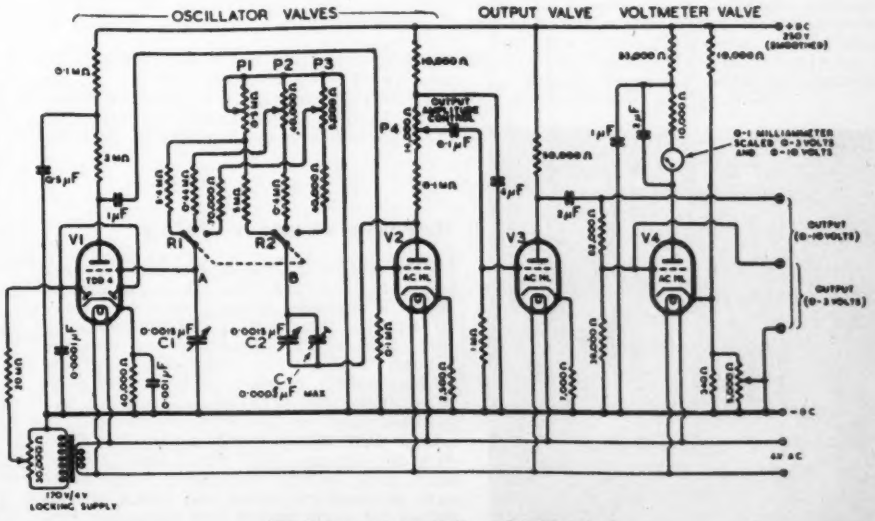
M. R. Rao (Indian Journal of Physics, Calcutta, Vol. XVI, Part VI)

Angle of incidence of 60 and 90 meter waves emitted by the Bombay and Madras broadcasting stations of the All-India Radio were measured, indicating the paths the waves had taken and the virtual heights of the reflecting ionospheric layers.

The angle of incidence—i.e., the angle between the direction of wave propagation of the received wave and the horizontal plane—is derived from the phase difference in the electromotive forces set up in two parallel horizontal antennas, which electromotive forces are applied to the horizontal and vertical plates of a cathode ray oscillograph, respectively. With the two signal strengths equal, the eccentricity of the ellipse on the cathode ray screen is indicative of the phase difference.

However, these patterns were often found to be unsteady. The ellipse rotated and changed its size and shape in a haphazard manner because waves traveling different paths and having different angles of incidence were received simultaneously. Different paths may correspond to different ionospheric layers or to multiple reflection, and the waves will arrive with different time delays according to the lengths of the paths taken. To obtain separate records corresponding to these components, the transmitter was made to radiate 0.0004

(*Continued on page* 142)



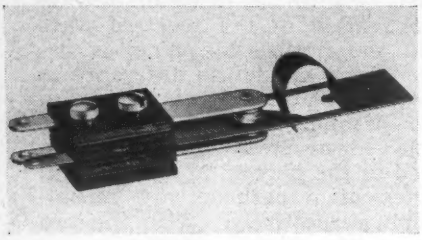
Resistance-coupled multivibrator

WHAT'S NEW

Devices, products and materials the manufacturers offer

Snap-Action Switch

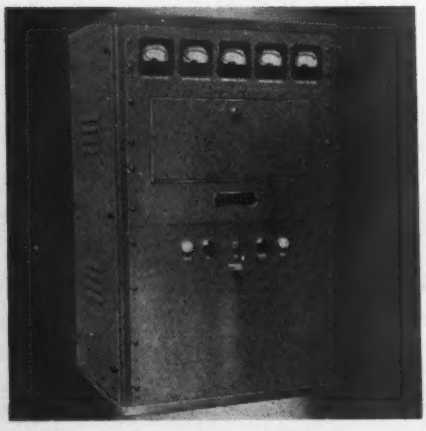
To secure better contact pressure and greater speed of operation, a new small open blade snap-action switch has been developed. A rolling spring produces a positive snap action with less than 6 oz. operating pressure. Consequently smaller coils may be used in relays incorporating this new development. The design minimizes contact burning because of its extremely fast action. This switch is also designed to permit both pre-travel and over-travel. It has a rating of 15 amps.



on 125 volts ac. Overall size is 3-1/16 x 11/16 x ½ in. It is made in single pole, single or double throw, set and return types, and also assembled to suit the needs of relay builders. It is manufactured by the Acro Electric Co., 1308 Superior Ave., Cleveland, O.

Communications Transmitter

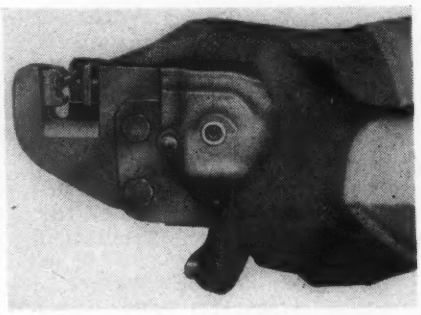
The Gates type MO-2535 communications transmitter is a medium power unit (200 watts output) for phone and cw telegraph operation with quick frequency change to any one of five crystal controlled frequencies within the range of 2-20 mc. Required frequencies are preset at the factory. The complete transmitter consists of two units, the transmitter itself in one case, 36 x 21 x 19 in., and the audio frequency switching controls in a console, 21 x 11 x 14 in.; the two are interconnected by means of a 16-ft. (or longer if needed) 16 conductor cable. Aside from an on-off switch on the transmitter, entire control, except for frequency changes is by means of the control console. The press-to-talk microphone switch operates a relay arranged to provide receiver cut-off. For cw operation, providing telegraph speeds up



to 60 wpm by means of a Leach relay, relays disconnect the modulators and make other adjustments to insure clean, chirpless keying. The key is in the cathode circuit of the oscillator, with the relay operated by a self-contained 12-v dc source. Modulation capacity is 100 per cent, audio fidelity 100-6000 cps with low distortion. The output coupling circuit is self-contained, and may be matched to available antenna equipment. Manufacturer is Gates Radio & Supply Co., Quincy, Ill.

Supplementary Terminal Tool

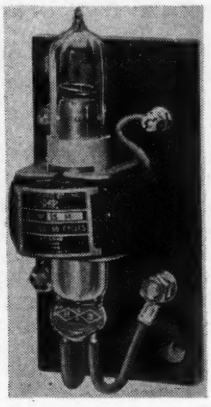
Improving the usefulness of several makes of standard compression tools for squeeze riveting, Thomas & Betts Co., Elizabeth, N. J., has developed a supplementary head to convert such tools for use in applying Sta-Kon wire terminals.



The supplementary heads install terminals on all wire sizes from No. 22 to No. 10, are supplied to fit tools made by Chicago Pneumatic Tool Co., Cleveland Pneumatic Tool Co. and Independent Pneumatic Tool Co.

Mercury Plunger Relay

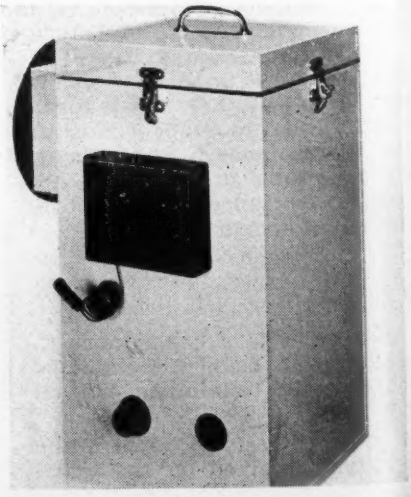
This normally closed mercury plunger relay is designed for any application where a normally closed heavy duty relay is required. The unit is gravity-operated. The plunger is designed to displace enough mercury to flood the contacts which consist of two pools of mercury. When the coil is energized, the plunger is lifted and the mercury recedes. This action permits the flooded pools of mercury to separate into two pools of mercury, thus opening the circuit. The mercury to mercury make and break is well suited for high inrush and inductive circuits. Relays can be furnished with coils



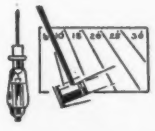
for any operating voltage and load rattings up to 4.5 kva. Units can be furnished with a variety of mountings and housings to meet individual requirements. It is made by H-B Electric Co., 6101 North 21st St., Philadelphia, Pa.

"Packaged Air" Source

For supplying either dry or humidified air for laboratory purposes at temperatures ranging from —95 deg. F. to +165 deg. F. a new portable Servo unit has been developed by Tenney Engineering Corp., 8 Elm Street, Montclair, N. J. The equipment uses 50 pounds of broken dry ice held in a light steel frame basket for the refrigerant and two 1000-watt electric strip heaters for heat. Air is circulated through the unit by an electrically powered multi-blade blower with a thermostat controlled damper which maintains temperature within ±2 deg. at —70 deg. F. The sensitive bulb of the thermostatic control may be placed either in the test space or in the air duct. The heaters may be used separately or together, providing rapid or slow temperature rise. The unit operates on 110-volts ac and draws 20 amps. External dimensions are 17 x 17 x 31 in.; it delivers 125 cu. ft. per minute at —100 deg. F.; heat delivered at +100 deg. F., is 680 deg. BTU per hour. The humidifier is an extra-cost accessory.



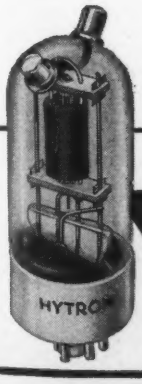
"How would you like to be hit several times with a hammer?"



Pity the Hytron tubes struck several sharp blows by a heavy, swinging hammer during the Bump Test. Only by such rough treatment, can rugged Hytron tubes suitable for the shocks of mechanized warfare be selected.

Even this trial is not enough. These quality tubes must withstand many other mechanical shock tests during which the stability of electrical characteristics is carefully measured while the tubes are tortured by scientifically simulated jolts and vibrations which might occur in actual combat.

Hytron engineers are quality conscious. Whether the test be mechanical or electrical, their purpose is the same—to supply our boys with tubes fit for service in bouncing jeeps, rattling tanks, shell-belching battleships, and darting, twisting, roaring fighter planes. Wherever Hytron tubes may be called upon to act as the dependable hearts of radio and electronic fighting equipment, they must be the best that can be made.



OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON

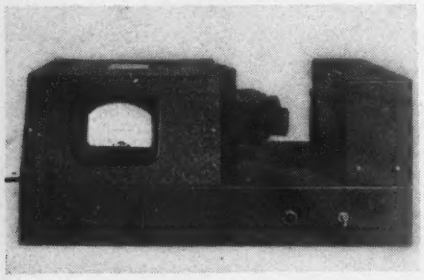
HYTRON RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

Measures Density of Transparent Materials

A densitometer, photoelectric system for accurate measurement of the density of transparent films, filters, plastics, gases, and liquids, has been manufactured by Photoswitch, Inc., 77 Broadway, Cambridge, Mass.

The densitometer projects two beams of light from a single light source, one passing through a standard filter; the other, through an object or liquid, the transparency of which is to be measured.



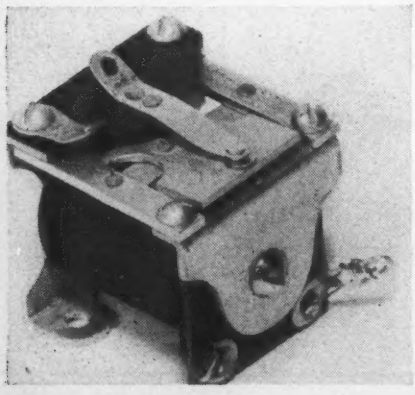
The two light beams are then projected by an optical system to a single phototube. By means of an electronic and mechanical timing system, it constantly measures the ratio of transparency of the sample as compared with the standard filter. As the same source of light and the same phototube and amplifying system are used to examine both standard and sample, the resulting measurements are independent of circuit constants, supply voltage and other ambient conditions.

Flexible Tubing

This new type rubber-like synthetic insulating tubing is made in two types. Synflex FT-11 for sub-zero applications, with a working range of —60 to 188 deg. F., and Synflex FT-22 with an elevated temperature resistance of 194 deg. F. and a dielectric strength of 1200 vpm; dielectric strength of FT-11 is 1000 vpm. Neither will support combustion, both have good chemical resistance and low water absorption. Sizes are made from .021 in. id to 2 in. id. Manufacturer is Industrial Synthetic Corp., Irvington, N. J.

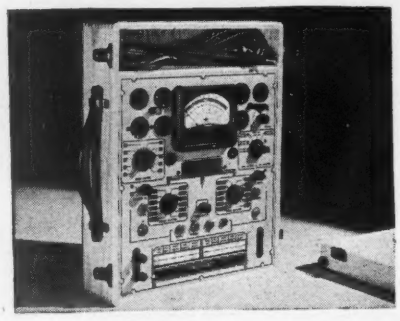
Light Weight Relay

A new light weight relay, miniature in size and operating at 0.2 watts has been developed by Control Corp., 600 Stinson Blvd., Minneapolis. The relay measures 1 in. on a side, weighs but 38 grams. Instead of the usual type bearing, a twisted leaf spring is used and the armature is mounted on it; there is no pivot or pin type bearing. Resilient mounting of the stationary contact eliminates bounce and gives a wiping action. The illustration shows a normally closed single contact type though a single pole double throw type is also furnished. Contacts are rated at 1 ampere at 24 volts, non-inductive.



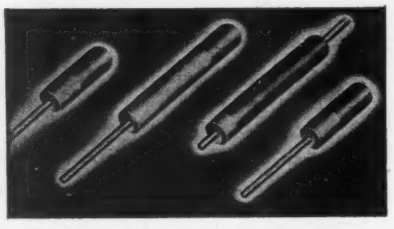
Portable Dual-Tester

A new model portable dual-tester with provision for testing all old and new type tubes including the acorn variety, and permitting voltage, current, resistance and capacitor measurements, has been developed by Radio City Products Co., Inc., 127 West 26th St., New York. Model 804 tester is contained in an oak cabinet, 14½ x 13 x 6 in. and operates on 105-135 v. ac. Both ac and dc voltmeter ranges read to 5,000 volts; milliammeter range: 1,000 ma; dc ammeter range: 10 amperes; ohmmeter range: 25 megohms. Included is an electrostatic leakage tester for mica and paper condensers, and a battery tester for determining the condition of the batteries by testing under load. The instrument is fully fused and provides for sensitive noise and hum tests.



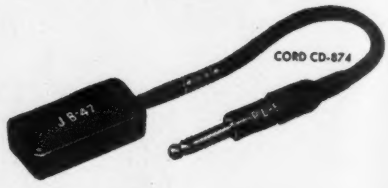
Insulated Iron Cores

For applications calling for iron cores having high unit resistivity, Stackpole Carbon Co. (Electronic Components division), St. Marys, Pa., has developed a special core material showing resistance of practically infinity. It is recommended for applications where a resistance of 150 megohms or greater is required and where voltages do not exceed the breakdown value. The product reduces leakage currents and their resultant noise troubles and in applications having cup cores there is no need for heavy insulation on lead wires.



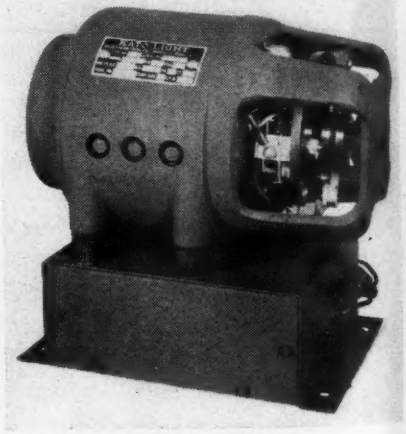
Junction Box Set

This cord set with junction box (JB-47) assembly unit consists of a length of CD-874 special, two-conductor, tinsel cordage with a PL-55 two-conductor plug attached to the cordage at one end, and a JB-47 junction box attached on the other end. The junction box has a two-piece Bakelite plastic case. The lower section of this case has two silver-plated, copper terminal jumpers, and four terminal binding posts for the necessary connections. Cord clamps are molded into both sections of the case, to hold the cordage in place and prevent slipping. A tight-fitting Neoprene jacket sleeve makes a close seal over the end of the plug, which is connected to the cordage. The complete cord set, or any integral part, can be furnished. Manufactured by Trav-Ler Karenola Radio & Television Corp., 1032 W. Van Buren St., Chicago 7, Ill.



Continuous Duty Converters

A complete line of newly designed, two pole converters has been brought out by the Kato Engineering Co., Mankato, Minn. These improved designs are available in 225 and 350 volt-amperes continuous load capacities at 3600 rpm. with 40 deg. C. temperature rise. Available for changing 32, 110, or 220-volts direct current to standard 110-volts, 60-cycle. They are designed to keep radio interference down to a minimum and to provide best possible wave forms to facilitate all phases of radio filtering. Special filters may be furnished in a sheet metal base upon which the converter is mounted. Upon specification, speed governor can be furnished which is helpful in maintaining close frequency control with a variable input.



Eraser Serves as Abrasive

Originally designed for use on ink or typing, the Rush-Fybrglass-Eraser is now being marketed as a versatile industrial abrasive instrument. The product consists of a bundle of finely spun glass fibers in a pencil-shaped plastic holder. As an abrasive, the closely-packed ends of the glass threads are about equal to the finest emery cloth, leaving a clean polished surface. The brush-like resiliency of the glass bundle allows quick and thorough cleaning or abrasing of uneven or pitted surfaces. Microscopic glass particles which may remain on the work have little or no effect on contact-resistance or on soldering, etc.

The holders are refillable. Erasers or Fybrglass refills are obtainable through stationers and office-supply dealers or direct from the manufacturer, The Eraser Co., Inc., 231 West Water St., Syracuse 2, N. Y.

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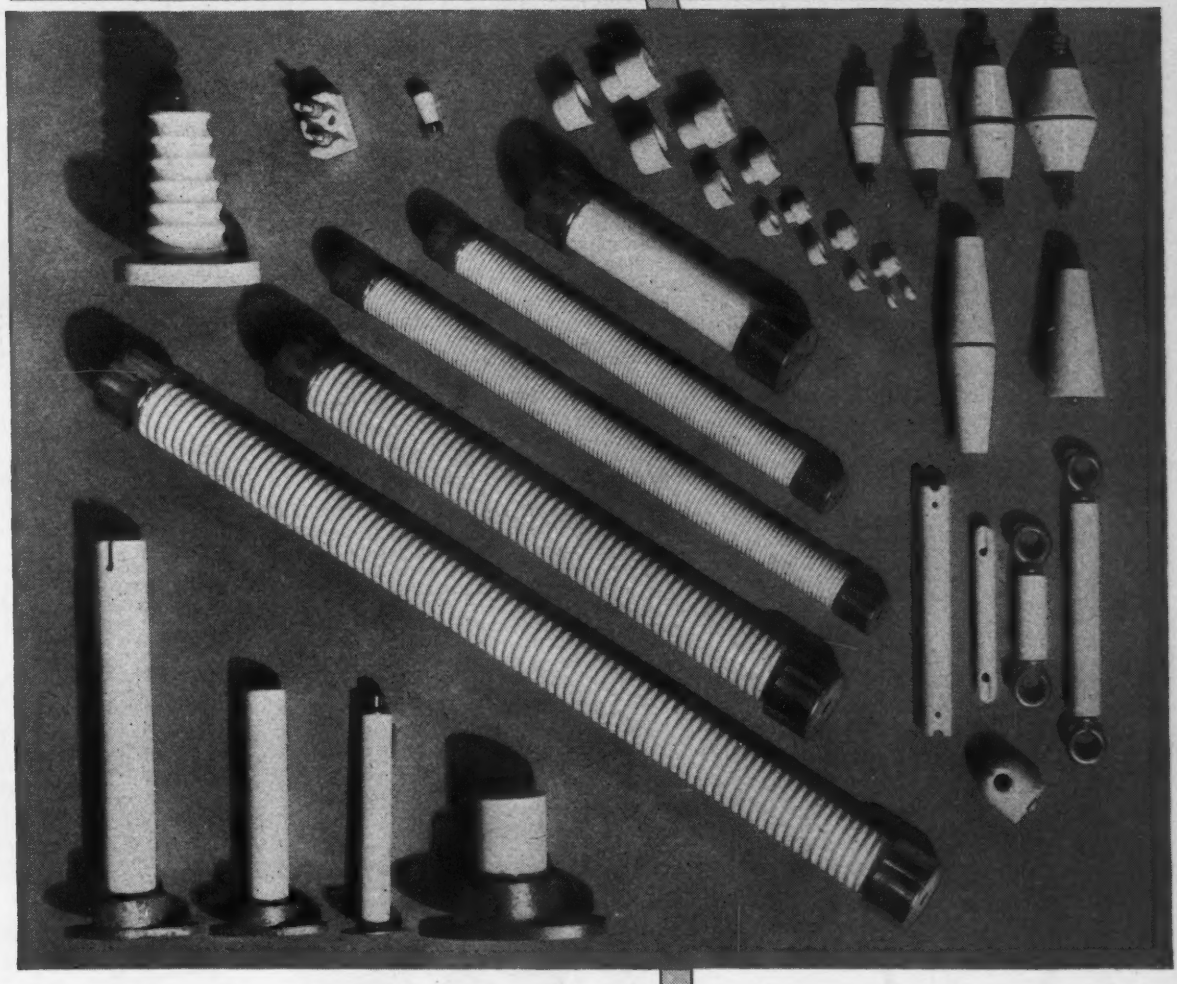

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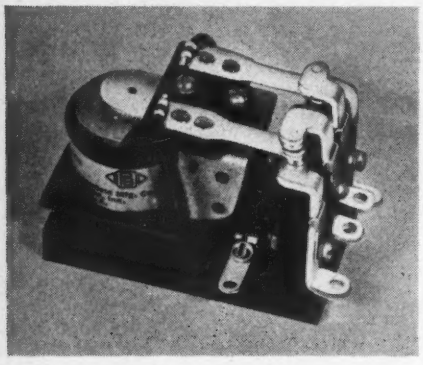
LATROBE, PA.

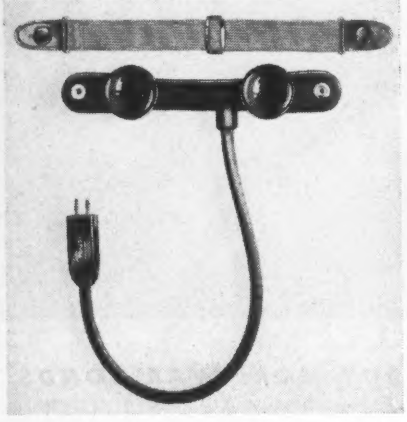
Shockproof Relays

A series of relays, known as the SP series, has been developed by the Potter and Brumfield Mfg. Co., Princeton, Ind., which are designed to withstand shocks and vibration. The unit construction of the bakelite molded base and stationary contact support eliminates the use of many screws and rivets as well as contributing insulation qualities. The armature frame and core are made of steel, heat-treated after fabrication and are cadmium-plated. Moving contact springs are tinned or silver-plated. Will carry a non-inductive load of 5 amperes at 110 volts 60 cycles. Available in both ac and dc types. Average size 2⅜ x 1⅝ x 1-1/12 in.



Throat Microphone

Model T-30 throat microphone, originally engineered to U. S. Signal Corps specifications, is now being made available by Universal Microphone Co., Inglewood, Calif., on bulk orders to government contractors. It is a dual element, carbon-type mounted in a synthetic rubber elas-



tic neckband. The plug is a non-locking breakaway type PL-291. Complete equipment requires the addition of an extension cord (CD354) and switch assembly (CD318 or CD508) containing the press-to-talk switch.

High-Voltage Tubular Capacitors

High voltage capacitors for X-ray, impulse generator and other intermittent dc or continuous ac high-voltage applications such as indoor carrier-coupler capacitors, test equipment and special laboratory work, have been developed by Aerovox Corp., New Bedford, Mass.

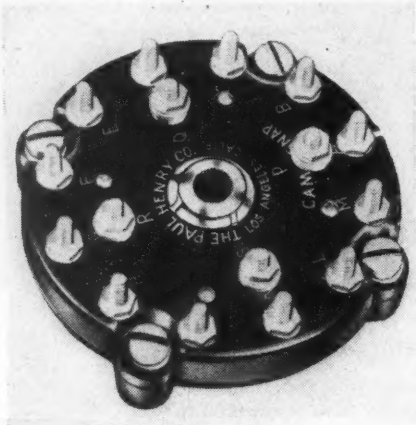
These capacitors are oil-impregnated and oil-filled with Hyvol vegetable oil. Insulated and matched sections of uniform capacitance are connected in series. Equal voltage stresses are maintained for all sections, with a uniform voltage

gradient throughout the length of each capacitor. High-purity aluminum foil with a generous number of tab connectors provides high conductivity with low inductance.

The case is laminated bakelite tubing, protected by a high-resistance insulating varnish for high dielectric strength and maximum safety from external flashover. Terminals are two-piece cast-aluminum end caps with bakelite-treated cork gaskets.

Rotary Selector Switch

A new type of selector switch, having one to four primary and 12 secondary circuit contacts, has been developed by Paul Henry Co., Los Angeles. The switch may be mounted singly or arranged in a gang with several switches operated by the same shaft. The shaft itself is serrated but may be either square or hex.



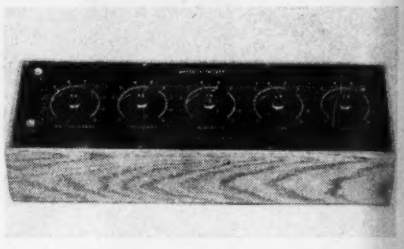
Any type of cam operating member can be used. Opening and closing of circuits requires but three or four degrees motion of the cam. Conservative current rating is 10 amperes at 29 volts, inductive load. The case is fully enclosed macerated phenolic; detent action can be furnished.

Power Resistors

Recently expanded facilities permit the Groves Corp., Cape Girardeau, Mo., to make quick deliveries of a new line of Class 2, Grade 1 fixed wire wound power resistors of the cement coated type. They are manufactured in accordance with the requirements of the American Standards Association specification G 75/370. The coating is a specially developed organic cement which will withstand severe conditions, including those encountered on shipboard or in humid climates. Non-hygroscopic steatite tubes are used with tinned copper terminal tabs or monel ferrules firmly secured to the tubes so as to withstand high torque. The normal operating temperature is 160 deg. C. and resistors are available in sizes ranging from 2 to 80 watts with either ferrule or radial tab terminals. Resistance values up to 75,000 ohms have 0.0025 in. wire; 270,000 ohms have 0.0015 in. wire.

Decade Box

Model 5 is a precise decade box providing a choice of any resistance from 1 ohm to 99,999 ohms in steps of 1 ohm. All decades are adjusted to an accuracy of 1/10th of 1 per cent and the resistors are all non-inductively wound with wire which has a temperature co-efficient of plus-minus .00002 between 20 deg. and 100 deg. C.

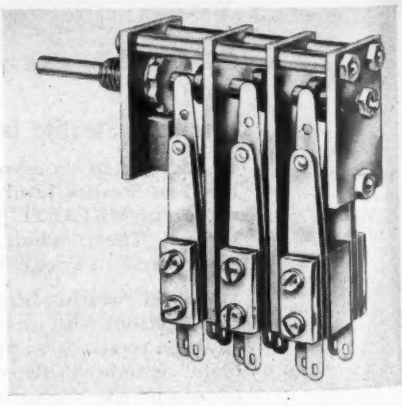


Low resistance switches are used throughout. The bakelite panel is engraved by the new "cut-in" process which eliminates the possibility of letters being scratched off. The instrument is housed in an oak cabinet, 18½ x 6½ x 3½ in. Price complete $59.50. Delivery on priority of AA-3 or better 15 days. Made by Superior Instruments Co., 227 Fulton St., New York 7, N. Y.

Rotary Switch

The General Control Co., Cambridge, Mass., announces a new rotary switch type MR having one to six positions with innumerable contact arrangements and sequences by means of adding cams and contact buildups.

It is for single hole mounting, the width and depth depending on cams and contacts required.



Manufacturers of products intimately related with the electronic field are invited to submit brief technical descriptions of new items placed on the market. Such descriptions may be accompanied by small electros, not exceeding 2 inches in width, or by sharp photographs on glossy paper.— Editor.

MICROPHONES—*Under Glass*

—We call it the [redacted] room at the plant because that's where we make those very special [redacted] microphones. But this we can say. New techniques in microphone manufacture involve such extreme care that workers operate in dustproof glass enclosed areas which are air conditioned and humidity controlled. Precision made—they are designed to stand up and perform under extremely difficult combat conditions.

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NEW PATENTS ISSUED

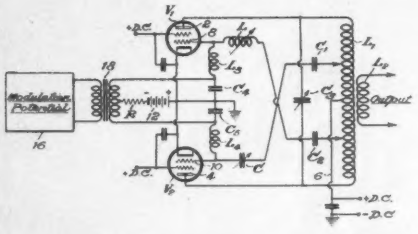
Summaries of inventions relating to electronic uses

Note: Date application was Filed shown by (F). Date patent Issued, (I). For the reader's convenience, patents most recently issued are presented first within their specific classifications.

FM AND PHASE MODULATION

FM Oscillator

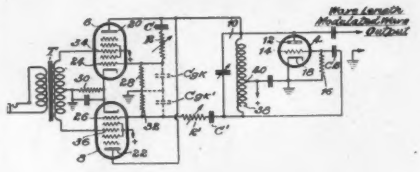
The invention refers to telephony, telegraphy, photo radio, television, etc. Tubes V_1 and V_2 are connected as a push-pull oscillator of relatively low Q with phase displaced feedback circuits, L, grid-cathode resistance of V_1, and C, grid-cathode resistance of V_2. The control grid capacities of the tubes tune out the inductances of chokes L_3, L_4. When tube V_1 has its control grid 8 modulated less negative to deliver more energy to tank circuit L_1, C_2 and grid 10 of tube V_2 is modulated more negative to deliver less energy to the tank circuit, then,



since the phase of the energy delivered by tube V_1 is lagging and that delivered by tube V_2 is leading, the phase and frequency of the oscillations in the tank circuit will slow down to a lower frequency, and vice versa. The amount of this frequency deviation from the average carrier frequency is proportional to the amplitude of the signal oscillations, and the frequency of the deviation is the same as the frequency of the signal oscillations. Modifications of the invention are described. G. L. Usselman, RCA, (F) Aug. 30, 1941, (I) Aug. 10, 1943, No. 2,326,314.

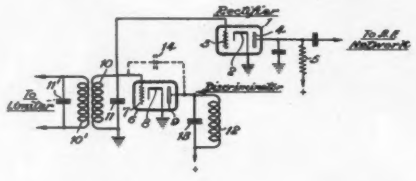
Reactance Tube Modulator

The two push-pull modulated reactance tubes 6 and 8 modify the frequency of oscillator tube 4. Phase-shifter for tube 6 consists of resistance R and grid-to-cathode capacity Cgk. C is a blocking condenser to keep the plate voltage off the control grid. R', Cgk' and C' have similar functions with respect to tube 8. The two equal phase shifter networks are fed from opposite ends of circuit 10 to provide the necessary 180 deg. phase shift for the two reactance tubes to act as capacitance and inductance, respectively. In another example shown and described, the two plates are connected to opposite ends but the two grids of tubes 6 and 8 to the same end of circuit 10. It is characteristic for the invention that like phase shifters are used for both reactance tubes, and the 180 deg. phase difference between them is obtained by feeding either their grids or their plates from opposite ends of the tuned circuit of the oscillator. To obtain phase modulation circuit 10 consists of the tuned circuit of a push pull amplifier. This amplifier then has its tuning modulated by the reactance tubes so that phase modulation of the carrier amplified by the amplifier is accomplished. M. G. Crosby, RCA, (F) May 8, 1941, (I) July 13, 1943, No. 2,324,282.



Discriminator

Owing to the mutual coupling of grid circuit 10,11 and plate circuit 12,13—both tuned to the center frequency—through grid-plate capacity 14, changes of impedance in the plate circuit due to frequency deviation of the incoming waves produce frequency-dependent damping of the grid circuit. This known effect is



used for discriminator action. In the embodiment shown a separate rectifier tube 1 is included in the circuit. However, when suitably connected, the discriminator tube may at the same time act as rectifier. S. Hunt, RCA, (F) Aug. 26, 1941, (I) July 6, 1943, No. 2,323,603.

MEASURING AND TESTING

Test Equipment

An apparatus for comparing the transmission of signal impulses from several transmitters and associated antennas as well as for comparing the transmission of signal impulses over several propagation paths between a transmitter and a receiver is described. De Witt Rugg Goddard, RCA, (F) Dec. 12, 1941, (I) July 6, 1943, No. 2,323,534.

Ionic Altimeter

The fact that air density varies with altitude is used to establish the altitude of a balloon or an aircraft by inserting an ionizing gap in the frequency controlling circuit of an audio oscillator. The amount of air in the gap determines the value of the resistance which in turn controls the audio note generated and used to modulate a small battery-operated ultra-high frequency transmitter. It will be seen that the audio note depends on the altitude of the balloon or aircraft carrying the transmitter. Ionization of the air gap may be produced by radio-active substances or by high voltages. To minimize inaccuracies due to temperature and humidity variations of the air in the gap during ascent, only a small hole connects the inside of the gap with the surrounding air allowing air to escape and establish equilibrium. F. W. Dunmore and E. G. Lapham, Secretary of Commerce, Government of the United States, Secretary of Commerce, (F) Feb. 5, 1940, (I) July 6, 1943, No. 2,323,317.

Vibration Testing

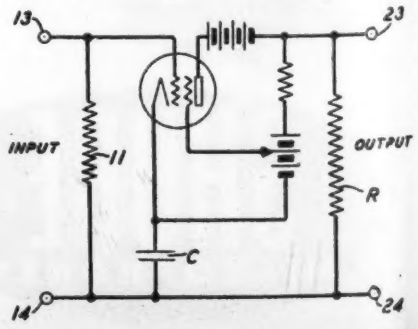
The material under test is vibrated over a wide frequency range and its natural frequency determined. The sample is vibrated at that frequency until its vibrating amplitude changes, indicating a change in its mechanical structure which subsequently results in failure of the material under test. By this expedient, the material can be observed and physical changes prior to destruction can be studied. A particular circuit is described and claimed. J. A. Hutcheson, Westinghouse Electric & Mfg. Co., (F) Aug. 2, 1940, (I) Aug. 3, 1943, No. 2,326,033.

Potentiometer Recorder

The invention relates to systems employing a galvanometer as a detecting means which, in response to unbalance of an electrical network, starts a motor, which in turn operates a rebalancing potentiometer. The rebalancing mechanism may be used to actuate a recorder or a correcting device. An electronic circuit is described which operates the device so as to minimize hunting and at the same time provide a small resistance in the galvanometer circuit. J. Razek, Thwing-Albert Instrument Co., (F) June 21, 1940, (I) Aug. 3, 1943, No. 2,325,801.

Differentiating Amplifier

It can be shown that the output voltage is proportional to the current through R which is the same as the current through C, and that the current through C is the differential of the charge on C which is determined by the input voltage. Thereby, the output voltage may be made proportional to the differential of the input voltage. Two and three stage amplifiers working on the same principle are described. They are operative over a wide frequency range including very slow direct current variations. E. L. Norton, Bell Telephone Labs., (F) Sept. 17, 1941, (I) July 20, 1943, No. 2,324,797.



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Wire-Testing Apparatus

The apparatus described includes a vacuum tube oscillator. The wire to be tested is rapidly moved along the axis of the tank-circuit coil, controlling its self-inductance. For the desired wire characteristics the oscillator produces oscillations which are indicated by a milliammeter in the plate circuit. Upon a change in the wire characteristics and in the coil inductance oscillations will cease causing a drop in plate current. A neon lamp is so connected in the circuit that it does not glow while the oscillator operates, but lights as soon as oscillations cease and stays lighted until manual operation of a switch by the operator. By this expedient, continuous observation of the device is made unnecessary. D. E. Elmendorf et al., General Electric Co., (F) June 25, 1941, (I) Aug. 10, 1943, No. 2,326,344.

TELEVISION

Measuring Frequency Changes

It may be necessary, for instance with regard to television synchronizing signals, to determine the rate of changes of some frequency. According to the invention, a beat frequency between the unknown frequency and a standard is derived. The resulting difference frequency is electrically differentiated in a resistor-condenser network, recorded by an ammeter and/or indicated by a cathode-ray oscillograph. If desirable, the original frequency may be multiplied and/or the wave-shape transformed to that of a purely sinusoidal wave. E. D. Goodale, (F) Dec. 27, 1941, (I) July 13, 1943, No. 2,324,077.

Television Tube

The invention concerns tubes where the electron beam is directed upon the target or mosaic electrode with a velocity approaching zero so that no secondary electrons are liberated, and where the electron paths are at right angles to the target electrode in the proximity of the latter. These electron beam characteristics are obtained by suitably arranging electrostatic fields. H. A. Iams, RCA, (F) Dec. 28, 1940, (I) June 29, 1943, No. 2,322,807.

Image Reproducing Tube

Essentially voltages representing point by point the picture to be reproduced are impressed upon an insulating grid of an electron tube so that different parts of the grid are at different potentials at any given moment. The grid is flooded with a continuous stream of electrons which is modulated to a different extent at different points of the grid and, upon passage there-through, forms a current the cross-section of which is representative of the optical image. This current impinges upon a fluorescent target electrode. Various suitable insulating grid structures are described, using secondary emission—in which case th ecathode emits an electron stream representative of the picture — photosensitive coatings, heat-sensitive coatings or photo-conductive coatings — in which case the picture is projected directly onto the insulating grid. In all these latter instances, the grid structure is such that voltages are developed over the surface of the grid which vary across the surface of the grid in accordance with the variations of light and shadow in the optical image projected thereupon. H. A. Iams, RCA, (F) Dec. 14, 1937, (I) June 22, 1943, No. 2,322,361.

THE PEACETIME MEASURES OF REFLECTION AND DEFLECTION.... WILL BE READ FROM

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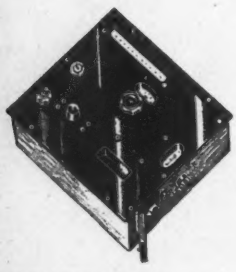

Coleman Universal Spectrophotometer Model 11 selects a monochromatic light band 35 mu wide, anywhere from 300-800 mu, with better than 2 mu precision. It passes light bands of any hue, including invisible bands at end of the spectrum, through any translucent product. Operation is simple.

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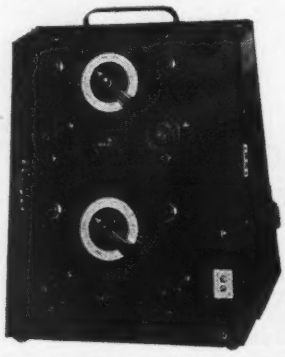

Coleman Anoxia Photometers, used in aviation, oxygen therapy, and anesthesia, employ Luxtron* cells in a diminutive photometer which clamps on subject's ear, projects light through membrane, then measures spectral characteristics of emergent beam, directly indicating degree of anoxemia. Models A (above) and 17, for aviation and clinical uses.

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Cathode-Ray Tube

Iconoscope pictures always exhibit more or less troublesome patches of light. These patches disappear at least partly if the metal coating on the inner glass wall is not connected directly to the positive pole of a source of direct current, as has been usual hitherto, but has a condenser inserted between the coating and the source. It is suggested to arrange a conductive screen adjacent the conventional mosaic screen. The conductive screen collects part of the secondary electrons, preventing them from impinging the back of the mosaic plate. G. Hepp and J. van der Mark, Alien Property Custodian, (F) Feb. 2, 1942, (I) Aug. 3, 1943, No. 2,325,676.

MISCELLANEOUS

Cathode Ray Tube

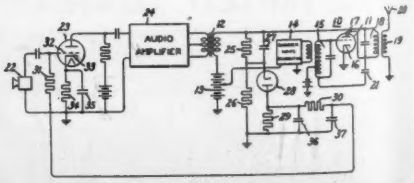
Accelerating electrodes and cathode of the tube are so arranged that a minimum radial field acts on the electron beam. An extremely small electron source surrounded by a ring-shaped member of substantially equal potential is provided in combination with a large cylindrical electron accelerator, so that the equipotential surfaces in the proximity of the cathode are essentially planes parallel to the cathode and the electrons are accelerated in axial direction only. No electrostatic or magnetic focusing is required. However, a coil is mounted outside of the electron accelerator and coaxial therewith to maintain the electrons emitted from the point source in a beam of substantially constant cross-section. Conventional deflecting means and a plate are included in the structure. L. E. Flory and A. W. Vance, RCA, (F) March 1, 1941, (I) July 13, 1943, No. 2,323,986.

Motor Synchronizer

The device is intended for synchronization of an induction motor driving a facsimile scanning apparatus. The voltage supply to the motor is varied in accordance with the phase relationship between the incoming synchronizing signal and a locally generated signal indicative of the motor speed. Also corrections derived from the printer signals are applied to the motor drive. M. Artzt, RCA, (F) Nov. 28, 1941, (I) July 27, 1943, No. 2,325,028.

Modulation Control

Amplitude modulation of a transmitter is to be prevented from exceeding a certain amount to avoid overmodulation, i.e., the modulating potential difference at the secondary transformer 12 should be less than the voltage of direct current source 13. Upon an increase in modulating potential beyond a predetermined value, a regulating potential is developed by diode 28 across resistor 29 which is applied to grid 32 to decrease the audio output. Resistors 25 and 26 act as voltage divider to impress across diode 28 only a portion of the unidirectional potential from source 13. Condenser 27, which has low impedance to audio signal currents, impresses substantially the en-



. . . at Work

Electronic science is serving America's wartime industry in countless ways. New and better techniques are being constantly developed. Established production processes are being speeded up and improved. Here are a few of the ways Westinghouse scientists and engineers are putting electronics to work.

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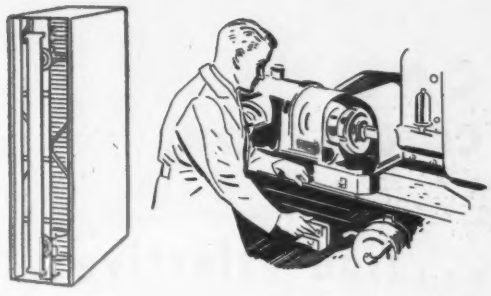

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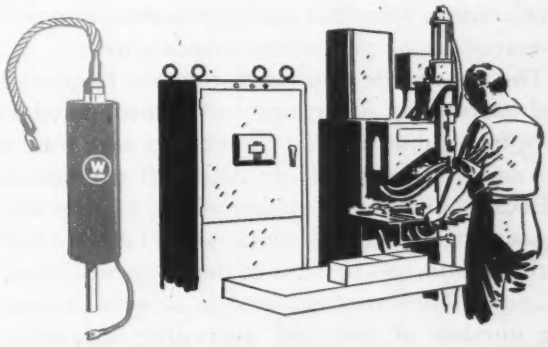

Storing Electrical Energy for resistance welding operations permits current to be drawn slowly from the a-c line—and applied in exactly equal amounts to produce strong, uniform welds. As the operator presses the switch, an exactly uniform amount of current is delivered for each weld by Ignitron tubes.

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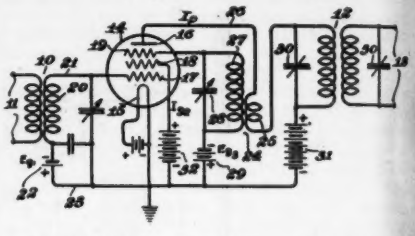
tire amplified audio signal across diode 28. In the circuits according to the invention, as distinguished from prior art circuits, the controlling potential across resistor 29 is not superimposed upon a positive unidirectional potential. Consequently, a low voltage diode may be used and the controlled audio amplifier may be operated with one side connected to ground. G. M. Brown, General Electric Co., (F) July 23, 1940, (I) July 27, 1943, No. 2,325,366.

Oscillator-Mixer Tube Circuit

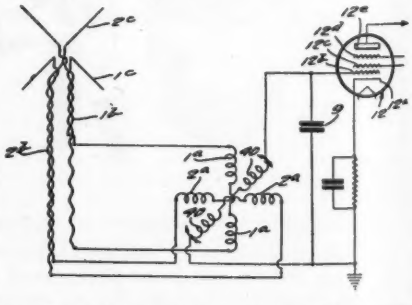
A single-tube oscillator-mixer circuit for superheterodyne receivers is described wherein interaction of radio and local oscillation circuits is minimized. In the embodiment shown, grid 17 is supplied with radio frequency signals, grid 19 operates as an oscillator at any frequency within the tuning range of condenser 28 and secondary 27. A virtual cathode is formed in the space between positive electrode 18 and second control grid 19, the density of which depends on the potential of grid 17. This virtual cathode serves as electron source for the oscillator section of the tube. Positive



grid 18 shields negative grid 17 from negative grid 19 and prevents interaction between radio frequency and local oscillator circuit. In other examples shown grid 17 serves as oscillator grid and grid 19 as modulator grid. A way of effecting automatic volume control is described. The arrangement works as detector-oscillator if the generated frequency equals the carrier frequency of the modulated input wave. J. C. Smith, RCA, (F) Jan. 31, 1933, (I) June 29, 1943, No. 2,323,250.

Directional Receiver

To provide a receiver for horizontally polarized waves, two pairs of similar horizontal doublet antennas are used. Directional characteristics are obtained by either alternately or simultaneously connecting both doublets to the input circuit. In the embodiment shown, coil 40 is rotatably arranged and may be coupled to



both antennas at a continuously varying degree. The directional effect obtained is the same as if one doublet were rotated. H. C. Forbes, Colonial Radio Corp., (F) Jan. 18, 1941, (I) May 25, 1943, No. 2,320,124.

BUY BONDS

SEPARATE LEADS AND WIDER PIN SPACING

make these RCA cathode-ray tubes useful for many war applications

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RCA-2AP1: A 2-inch high-vacuum tube, similar to the RCA-902, but with separate leads to all electrodes, and higher anode voltage rating. Magnal 11-pin base.

RCA-3BP1: A 3-inch high-vacuum tube. Electrostatic focusing and deflection. Green fluorescence. Medium persistence. Neck diameter, 2 inches. Overall length, 10 inches. Diheptal base.

For other important uses here are three outstanding RCA Cathode-ray tubes

RCA-3EP1/1806P1: Similar to RCA-3BP1, except: a) Neck diameter is 1⅝ inches; b) Magnal base; c) Cathode connected to heater inside of the tube.

RCA-5CP4: A 5-inch, high-vacuum tube with extra high voltage electrode, (anode No. 3). Electrostatic deflection and focusing. Separate leads to *all* electrodes. White fluorescence. Medium persistence. Neck diameter, 2 inches. Overall length 17 inches. Diheptal base. Anode No. 3 brought out to snap terminal on bulb.

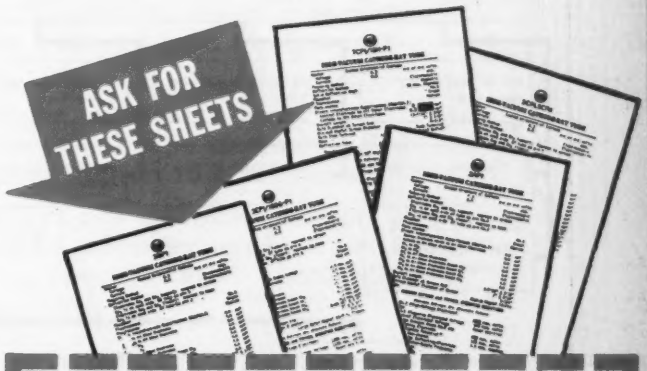
RCA-7CP1/1811P1: A short, 7-inch, high-vacuum tube. Magnetic deflection. Electrostatic focusing. Green fluorescence. Medium persistence. Neck diameter, 1⅝ inches. Overall length, about 13½ inches. Octal base. Separate leads for all electrodes. Anode No. 2 brought out to snap terminal on bulb.

RCA Victor Division • RADIO CORPORATION OF AMERICA • Camden, N. J.

The Magic Brain of All Electronic Equipment Is a Tube—and the Fountain-Head of Modern Tube Development Is RCA.

TUNE IN "WHAT'S NEW?"
RCA's great new show, Saturday nights, 7 to 8, E. W. T., Blue Network.

RCA ELECTRON TUBES



RCA Commercial Engineering Section
Radio Corporation of America
508 South 5th St., Harrison, N. J.

Please send me the data sheets on the following tubes:

☐ 2AP1 ☐ 3BP1 ☐ 3EP1
☐ 5CP4 ☐ 7CP1

Name.....

Company.....

Street.....

City.....State.....

Revise Radio-Radar Division

Executive sub-division created with three new offices to relieve top experts—Decentralization program functioning smoothly

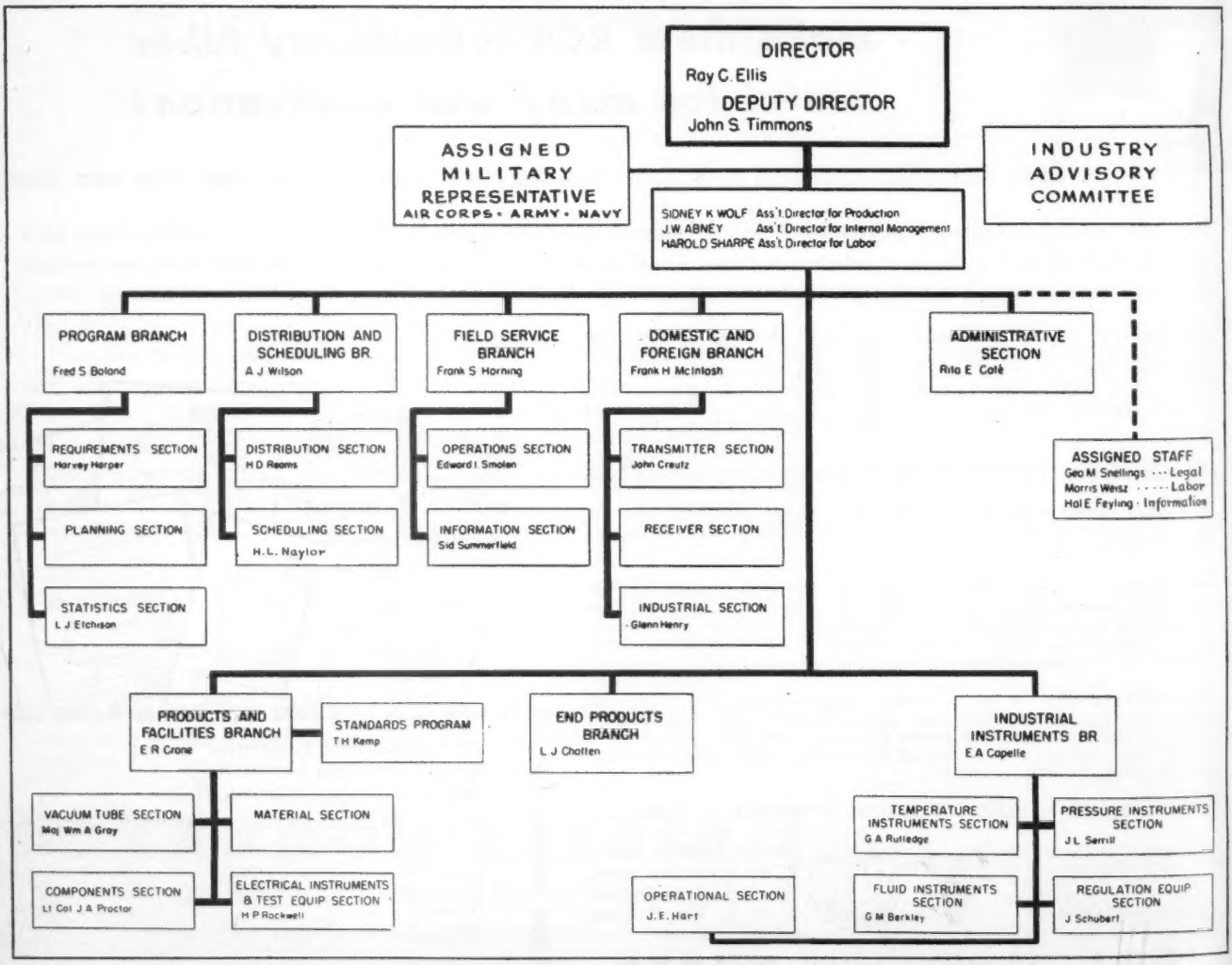
In a move to conserve manpower and employ to the fullest the special skills of its top experts, the Radio and Radar Division of the War Production Board has created an executive sub-division of its office of the director with the establishment of three new offices, that of assistant director for production, headed by Sidney K. Wolf; assistant director for internal management, headed by J. W. Abney; and assistant director for labor, headed by Harold Sharpe.

Officers of the three new sub-divisions will report directly to Ray C. Ellis, chief of the Radio and Radar Division, and John S. Timmons, deputy director. Each office will function in the handling of details that stem from various branches of the Division, and are expected to streamline the functions of the director's office.

Sidney K. Wolf, new assistant director for production

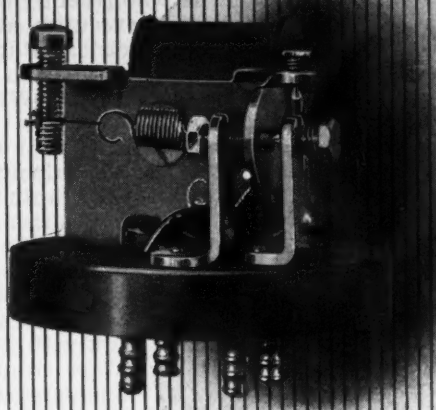
As assistant director for production, Mr. Wolf, who has just returned from a trip to the Aleutian Islands, will coordinate the activities of the production branches within the division, including the products and facilities branch, the end products branch, the labor and manpower branch and the industrial instruments branch. Mr. Wolf has been with the Radio and Radar Division since its inception.

Mr. Abney, who has served with the Government in administrative capacities for the past eight years, and has been with the WPB for the last year and a half, will handle all inter-divisional matters, specifically

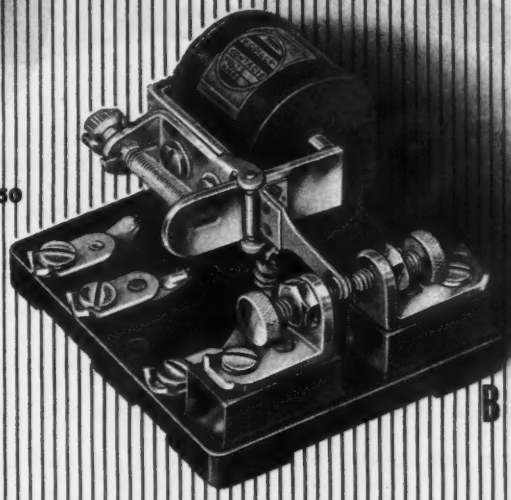


Organization chart of WPB's Radio and Radar Division, revised to improve effectiveness

ALLIED



G operating wattage 0.050



B operating wattage 0.012

Sensitive and Close Differential RELAYS

Ruggedness and Sensitivity are built into Allied's B and G Sensitive and Close Differential Relays. These essential factors, Stamina and Lightning Response, enable B and G Relays to withstand the grueling punishment of use in air, sea and land equipment.

B Relays have precision bearings with stainless steel shafts. G Relays have watch type pivoted bearings. These exclusive features keep operating friction to a minimum.

B and G Relays are designed to meet Army, Navy and CAA specifications . . . shock and vibration . . . temperature . . . humidity . . . salt spray . . . etc.

OPERATING CHARACTERISTICS

B and G Sensitive and Close Differential Relays are made in Single Pole Single Throw, Normally Open . . . Single Pole Single Throw, Normally Closed . . . and . . . Single Pole Double Throw.

Dimensions: G-1 7/8 x 1 7/16 in.
B-2 3/8 x 2 3/4 x 1 3/4 in.

Weights: G-3 1/2 ounces
B-7 ounces

ALLIED CONTROL COMPANY
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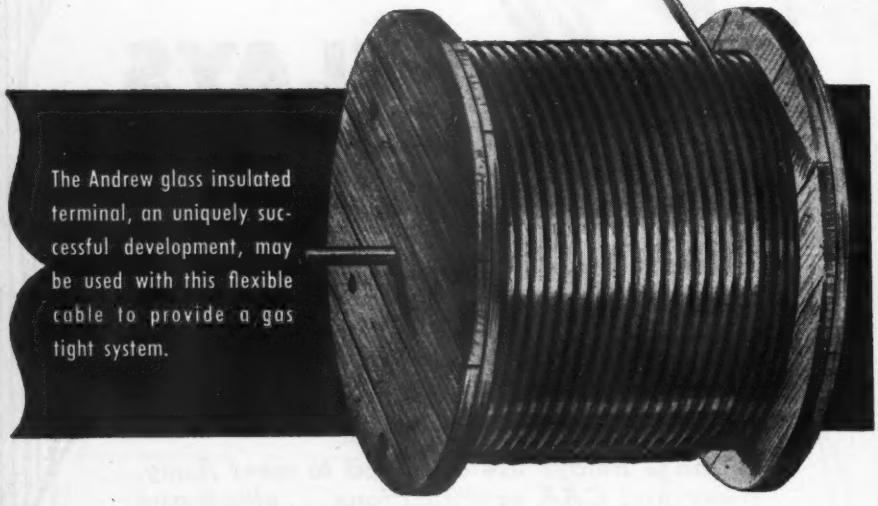
7/8" Soft Temper Copper

COAXIAL CABLE

1/2 YARD - OR 1/2 MILE

In One Piece !

The Andrew Company is now able to supply standard 70 ohm 7/8" soft temper coaxial cable in continuous lengths up to 4,000 feet! The cable is electrically identical to rigid cables of equal size, but has these extra advantages: the cable may be uncoiled and bent by hand, thus greatly simplifying installation; no connectors, junction boxes or expansion fittings are necessary, thus effecting a big saving in installation time and labor. To insure that all splices are pressure tight and that all foreign matter is excluded in shipment, the cable may be fitted at the factory and shipped to you under pressure.



The Andrew glass insulated terminal, an uniquely successful development, may be used with this flexible cable to provide a gas tight system.

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The Andrew Company is a pioneer in the manufacture of coaxial cables and accessories. The entire facilities of the Engineering Department are at the service of users of radio transmission equipment. Catalog of complete line free on request.

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directing his efforts toward the maximum use of the division's personnel.

Mr. Sharpe, who recently resigned from his post as executive secretary of the United Electrical, Radio and Machine Workers (CIO) to accept the assignment with the WPB, will devote his full attention to the manpower requirements of the industry. One of his principal duties will be that of anticipating shortages which may arise within the industry that tend to affect production. He will be in close liaison with manpower executives in other government agencies and industry, and will work with the Signal Corps labor offices throughout the country. (It is understood that posts comparable to that occupied by Mr. Sharpe in the Radio and Radar Division are now being established in other divisions of the WPB and in similar divisions in other government agencies.)

The office of the assistant director for labor within the Radio and Radar Division was set up in accordance with the direct joint orders of WPB manpower requirements vice chairman John S. Golden and WPB labor production vice chairman Joseph Keenan. In his work for the Radio and Radar Division Mr. Sharpe will act for both, but will report directly to Mr. Ellis.

Other branches of the Division remain substantially the same, although it is understood that a considerable concentration of the division's work is being turned over to the field service branch, headed by Frank S. Horning, for direct handling in the regional offices. Wherever necessary, the division maintains one or more radio experts to work directly with the industry in various regional offices throughout the country. As a result of this program, problems are handled "on the spot," relieving the division's Washington office of considerable detail. Questionnaires are now routed through these experts in the field, again cutting down on the amount of paper work in the headquarters office. This "decentralization" program, instituted some time ago, is now reported to be functioning smoothly.

WPB Local Service Branches

Radio and Radar Division of the War Production Board, which has its headquarters in the Social Security Building, Washington, has established seventeen field service branches as follows:

Boston, Mass.—17 Court St., Phone: Lafayette 7500—Michael Scott.

New York, N. Y.—Empire State Bldg., Phone: Murray Hill 3-6805—Frank S. Misterly.

Newark, N. J.—Globe Indemnity Bldg., Phone: Market 2-0700—Charles Eppleur.

Buffalo, N. Y.—1138 Rand Bldg., Phone: Madison

If you believe in the future of America as we do, then we're asking for an appointment immediately after the victory has been won . . . when a bright new era awaits us all.

Perhaps we can talk about a coil problem . . . how thoroughly we're organized to help you on such a problem only military censorship forbids telling now. Or it may be that you manufacture your own coils and will be interested in discussing magnet wire—any shape —any insulation that your operations require.

As a matter of fact, perhaps we can get together now, but if it happens we can't, remember we have a date in and for the future. When we both can keep it, you can again take advantage of Anaconda service and the benefits derived from the single product control "from mine to consumer" backed by years of continuous metallurgical experience.

43235

ANACONDA WIRE & CABLE COMPANY
General Offices: 25 Broadway, New York 4
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Subsidiary of Anaconda Copper Mining Co.
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ANACONDA
from mine to consumer

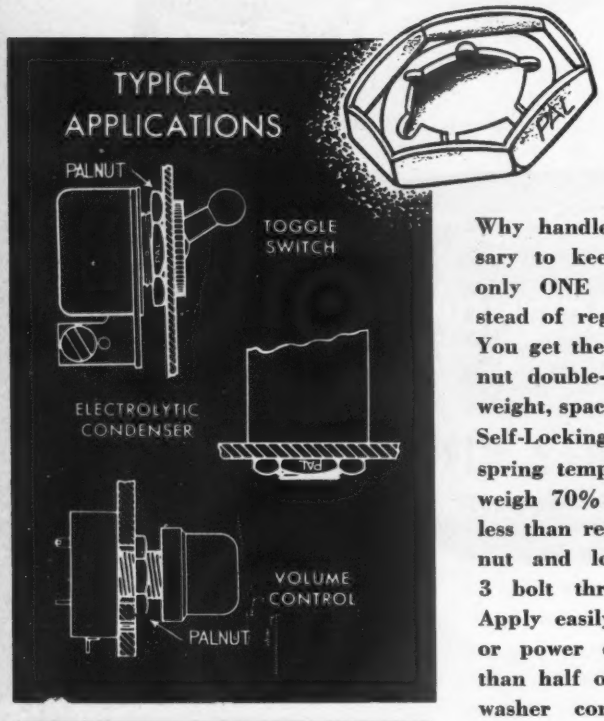
This familiar trade-mark symbolizes the best efforts of modern research and production.

Magnet wire and coils

ANACONDA WIRE & CABLE COMPANY

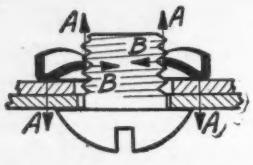
SPEED UP ASSEMBLY!

Fasten and Lock in ONE operation with SELF-LOCKING PALNUTS!



SAVE BRASS, STEEL, TIME AND LABOR

Why handle more parts than necessary to keep assemblies tight? Use only ONE Self-Locking Palnut instead of regular nut and lockwasher. You get the unfailing security of Palnut double-locking action — yet save weight, space, assembly time and labor. Self-Locking Palnuts are single thread, spring tempered steel locknuts. They weigh 70% less than jam nuts, 80% less than regular nuts, 90% less than nut and lockwasher. Require only 3 bolt threads to lock effectively. Apply easily and speedily with hand or power drivers. Palnuts cost less than half of a regular nut and lockwasher combined. Used for more than 10 years on radio, electrical and all kinds of mechanical equipment.



DOUBLE LOCKING ACTION

When the PALNUT is tightened, its arched slotted jaws grip the bolt like a chuck (B-B), while spring tension is exerted upward on the bolt thread and downward on the part (A-A), securely locking both.

IMMEDIATE DELIVERY can be made on Palnuts, in a wide range of sizes, finishes and materials. Send details of your assembly for suggestions and samples of Palnuts.

WRITE for Palnut Manual No. 2 giving details of principle, advantages, applications, types, sizes and materials.

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Self-Locking PALNUTS

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Atlanta, Ga.—116 Candler Bldg., Phone: Walnut 4121—Guy Mankin.
Cleveland, Ohio—1317 Union Commerce Bldg., Phone: Cherry 7900—H. J. Shartle.
Cincinnati, Ohio—34 E. Fourth St., Phone: Parkway 0100—M. G. Thomas.
Pittsburgh, Pa.—1st National Bank Bldg., Phone: Grant 5370—Wm. H. Martin.
Chicago, Ill.—226 W. Jackson Blvd., Phone: Andover 3600—Raymond H. Woodford.
Kansas City, Mo.—Mutual Interstate Bldg., Phone: Victor 7780—F. H. Larrabee.
Dallas, Texas—910 Fidelity Bldg., Phone: Riverside 5711—R. C. Watson.
Denver, Colo.—Continental Oil Bldg., Phone: Tabor 3173—George Jos'yn.
San Francisco, Cal.—1355 Market St., Phone: Klondike 2-2300—H. S. Ayers.
Los Angeles, Cal.—1031 So. Broadway, Phone: Richmond 1261—Herman Schmieter.
Detroit, Mich.—7310 Woodward Ave., Phone: Trinity 2-4900—L. A. Carlson.
Minneapolis, Minn.—334 Midland Bank Bldg., Phone: Main 3244—H. M. Richardson.

Operating Supplies Ratings

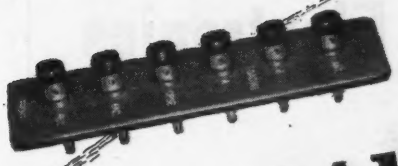
Preference ratings assigned for maintenance, repair and operating supplies, under CMP Regulation No. 5, have been adjusted by WPB to a new pattern of relative industrial urgency, recently established by its requirements committee.

At the same time, Schedules I and II of the Regulation, which indicate the ratings assigned to producers of particular products and to particular industries, have been modified to reflect the existence of specific MRO preference rating orders which are applicable to specific industries. Changes in ratings are indicated in Schedules I and II of the Regulation, as amended September 13, 1943.

At the same time, Direction No. 12, to CMP Regulation No. 5, indicates that orders placed for MRO items prior to August 16, 1943, for delivery in the third and fourth quarters, need not be down-rated in the case of producers of products or businesses which have been moved from Schedule I to Schedule II by the September 13 amendment to CMP Regulation No. 5.

Industrial Priorities

No change in priority ratings for key components of industrial instruments as the result of a meeting between representatives of the Industrial Instruments Advisory Committee and the War Production Board on the proposed reduction would be detrimental to the industry. The proposed basic rating assigned to industrial instruments is AA-2x. It was pointed out that only a small percentage of the overall production of key components was used by the industry, but that industrial instruments should have a priority rating commensurate with their essentiality as key equipment for every vital war program. The industry is operating at the rate of 200 million dollars a year.

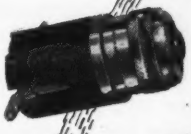


P-1921

DOING A BIG JOB IN RADIONICS

Closely allied with many electronic developments during the past twenty years, it's been our assignment to provide numerous component parts to the leaders in the field. Some of these components are simple to manufacture, others are more intricate—in any event, each one is doing a big job in today's electronic applications.

Thousands of ARHCO parts roll out of our plant every day. Always built to superior standards, they've been improved to an even higher degree because of stringent wartime specifications. We welcome your inquiries.



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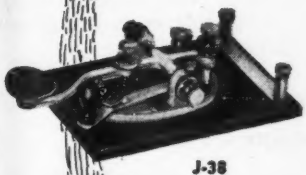

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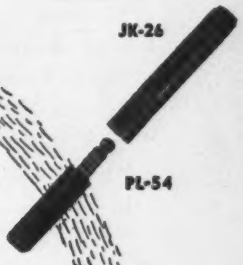

JK-26

PL-54

PL-55

J-670

P-1752

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MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

A Fast-Growing Company Specializing in Electronics

and having
A Proud War Production Record—
A Substantial Post-War Future and
A World-Wide Background of
Electronic Research and Development

● invites additional applications from technically trained American citizens having the following basic qualifications:

Electronic Engineers—High calibre men with proven technical ability and a well-balanced background of acoustics, broadcasting, frequency modulation and ultra high frequencies. Opportunities exist in the research, designing, development and manufacturing of electronic products in general, particularly cathode ray, transmitting and special-purpose tubes; communications, electronic and precision test equipment.

Also an opportunity for a physio-chemist, preferably with electrochemical experience.

Women with technical knowledge will be considered.

In addition, applications are invited from technically experienced men with commercial qualifications:

Commercial Engineers—Several of these men required. Should have sound technical knowledge in communications, special device circuits, quartz crystal and electronic tube applications, with knowledge of quartz crystal and electronic tube manufacturing processes.

Also one man who should have a background as metallurgist or physicist and preferably some practical experience with x-ray techniques.

Duties of Commercial Engineers will consist largely of personal contact and correspondence with engineering personnel among manufacturers of electrical and communications equipment, also with Government engineers.

If congenial association with a young and progressive organization fits in with long-range plans for your own future development and prosperity, let us hear from you now. Tell us your age and enough about your technical education and training, experience, draft status, availability and salary requirements to warrant an early interview in New York City, Dobbs Ferry or some mutually convenient point. A photograph will be appreciated. Address your letter in strict confidence to:

OFFICE OF THE PRESIDENT

NORTH AMERICAN PHILIPS COMPANY, INC.

DOBBS FERRY, WESTCHESTER COUNTY, N. Y.

If you are now working in an essential industry at your highest skill, please do not apply.

Provide More Production For Test Equipment

To meet increasing requirements of the armed services for electronic test equipment, a plan for wider subcontracting of orders for critical test equipment, test instruments and component parts has been initiated by the Radio and Radar Division of the War Production Board.

Two surveys have been launched by the Radio and Radar Division in its plan to place this extra demand on the test equipment industry in places where facilities and competent personnel already exist, since the expansion of facilities is impractical for lack of time, construction materials and new personnel.

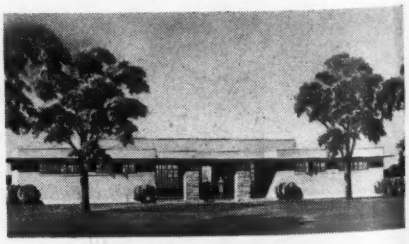
Regional offices of WPB have been requested to furnish detailed reports on manufacturers and facilities available for prime or subcontracts for producing test equipment, test instruments and components. At the same time, each manufacturer of electronic test equipment has been asked to indicate which firms would be most capable of adapting themselves to produce, under sub-contract, items for the manufacturer's schedule.

In a letter to manufacturers of electronic test equipment, Ray C. Ellis, Director of the Radio and Radar Division, stated that the armed services have given notification that requirements for test equipment needed to manufacture, install, maintain and service equipment for the future will increase substantially.

Tube Industry Model for Manpower Survey

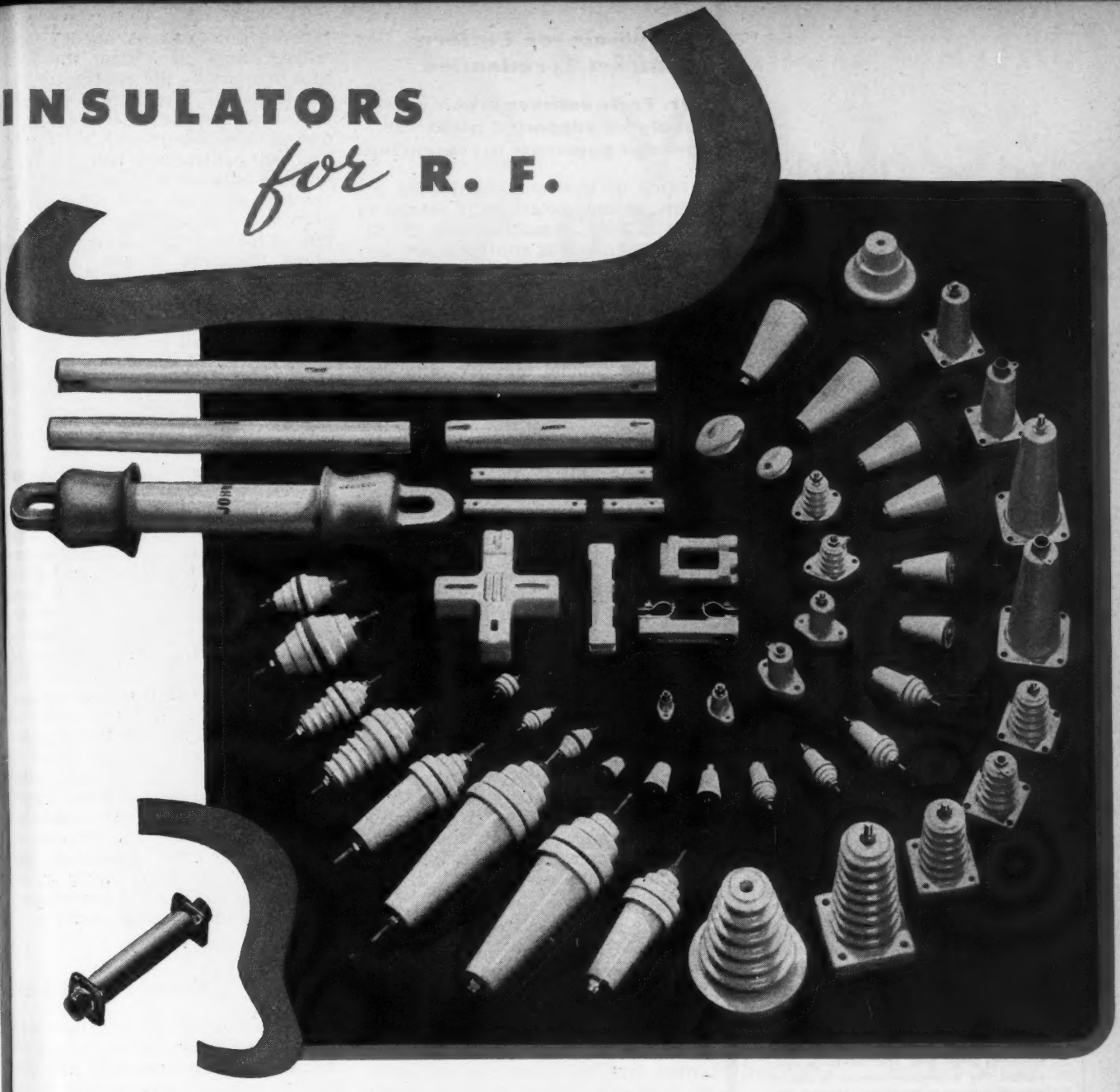
The vacuum receiving tube industry has been chosen as a guinea pig by the WPB Office of Labor Production for a survey of manpower problems. If a satisfactory procedure is attained in this study it will be extended to the entire electronics manufacturing field. The WPB officials said steps to combat turnover and absenteeism would include increased manhours, day nurseries for women workers and assurance of adequate transportation facilities.

Blue's Key Station



When WJZ transmitter finally is moved to its new location at Lodi, N. J., it will occupy this modern building, now under construction

INSULATORS *for* R. F.



Many commonly used insulating materials function perfectly in low frequency circuits such as audio, 60 cycle power or even the lower radio frequencies. These same materials at medium or high radio frequencies act as high resistances to waste precious R. F. Many porcelains, steatites, glasses and similar materials have this fault and only tests under laboratory conditions will detect it. Johnson insulators were not only designed for high R. F. but the materials were selected only after exhaustive tests to determine the best. Can you afford to take chances? Demand the best—they cost no more—specify Johnson.

Ask for CATALOG 9670

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Designed for Application

Another exclusive Millen "Designed for Application" product. Combination high voltage terminal and thru-bushing. Tapered contact pin fits firmly into conical socket providing large area, low resistance connection. Pin is swivel mounted in cap to prevent twisting of lead wire. Easy to use. ¼" o.d. insulation high voltage cable fits into opening in cap. Bared conductor passes thru pin for easy soldering to pre-tinned tip of contact plug.

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Standard 37001 available in either black or red bakelite. No. 37501 is low loss mica filled yellow bakelite for R.F. applications.

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MAIN OFFICE AND FACTORY

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Proposals for Uniform Contract Termination

Dr. Teele outlines problems and analyzes suggested plans for prompt payments to contractors

One of the most significant recent pronouncements in regard to the orderly demobilization of industry when war contracts are terminated was an address in Chicago by Dr. Stanley F. Teele, Deputy Director of the War Production Board Procurement Policy Division in which he stressed that the government should develop and get into operation in the most expeditious possible manner machinery designed to assure "quick cash" payments prior to final settlement. Dr. Teele stated that the present policy of the Army and Navy in respect to prompt partial payment on terminated war contracts contained a primary difficulty in connetcion with the hesitancy of contracting officers to approve payment without convincing and conclusive evidence to support any conclusion that the amount paid is "clearly within the amounts due."

The WPB official proposed that the related issues of prompt termination of contracts and financial compensation to workers who are laid off should be given serious consideration, both within the government and outside, to provide uniform and matured conclusion when the time comes for the termination of war production.

Pay all costs

On most of the important policy issues regarding the termination of war contracts judgments have not yet been crystalized and decisions have not yet been made, Dr. Teele noted, but he gave encouragement to industry, "that there is every intention within the government to work out these problems as rapidly and with as much wisdom as possible." He added that he could state emphatically that he knew of no policy-making official in the War and Navy departments who "does not subscribe wholeheartedly" to the intention to reimburse the contractor for all costs incurred and all commitments entered into in good faith for the performance of a contract.

He pointed out that industry should observe closely the situation and watch for the proposed uniform termination regulations now being framed by the armed services. He outlined the three principal proposals which have thus far emerged—advanced payments, loan, and purchase by the government of the rights of sub-contractors. He reviewed the bill of Senator Murray of Montana to provide that every federal procurement agency shall within thirty days after the filing of a demand by the contractor, pay the latter not less than 75 per cent of the amount certified by him as due on the contract with both prime and sub-contractors being covered and the balance to be returned with interest at 5 per cent. The second plan is the establishment of a system of loans or guarantees of loans along the lines of the present V loans through local financial institutions and Dr. Teele felt that such a program is desirable and can be administered in such a way as to be not at all consistent with the plan for mandatory advanced payments on certification.

Quick payments

The third proposal seeks to meet two related objectives—quick payments to sub-contractors and assurance to sub-contractors that their claims will be paid even if their customer (a prime contractor) becomes insolvent. This proposal is that the government be authorized by legislation to purchase the rights of sub-contractors against their customers, up to a limit of 90 per cent of the estimated value of the rights prior to final proof of the claim with 100 per cent after the rights have been proved. Under this latter proposal the sub-contractor would take his chances on payment by the customer but would have the opportunity to secure payment from the government if the customer became insolvent.

Funds for workers

It was pointed out that the dollar volume of war production now running at approximately 100 billion a year, is represented by a quarter of a million prime contracts and many million sub-contracts. Besides the "quick cash" problem for the contractors and sub-contractors, Dr. Teele stressed as a second problem that funds must be provided for workers laid off after termination of war contracts during a period when concerns will be struggling with the physical conversion of their plants for civilian production and planning of sales and distribution organizations and relationships.

A third problem is the prompt removal from plants of raw materials, work in process, finished goods and machinery no longer needed because of termination of contracts so as to not hamper conversion to civilian work. In addition there are the grave issues of the disposal of surplus property without adversely affecting the markets and employment.

A NEW HIGH-WATTAGE VOLTAGE REGULATOR

by WEBSTER

FEATURING ECONOMY OF SPACE FOR AIR-BORNE APPLICATIONS

Occupying exactly the same chassis space as previous conventional designs . . . with 8% less cubic volume . . . only 6% heavier . . . *but dissipating 300 to 400% more power*—these are the remarkably advanced performance specifications of the new Webster-developed VR-2200 Series carbon pile voltage regulators.

Manufacturers of communications equipment are invited to consult with us regarding the many advantages of this new design. We will make every effort to adjust our production to meet all urgent requirements.

Illustrated at right are standard model Webster voltage regulators.

WEBSTER PRODUCTS

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WASHINGTON

★ ★ ★ ★ **Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau** ★ ★ ★ ★

LONG WAY TO GO—The newspaper stories about cancellations and terminations of war production do not apply to the electronic and radio manufacturing industries. Manufacturers in our field can plan for their work on the basis of the global war. When the European phase of the war is over, the Army's requirements may well fall off to some extent as the concentration of the United Nations' attack is turned against the Japanese in the Pacific. But then the Navy's needs for electronic and radio equipment will be uppermost. The transition to civilian production can be implemented in an orderly way in such a situation when the Army's requirements begin to slacken off. Right now practically all of the major electronic-radio companies are booked to the hilt in war production.

. . . —

HIGHER GAINS NEEDED—The increases in production both for the Army Signal Corps and the Navy's Radio Division of its Bureau of Ships have been most gratifying in the past two months. Substantial increases still face the manufacturers before the peak production necessary to comply with the requirements of the armed services. Under the leadership of Major General William H. Harrison, Chief of the Signal Supply Services, the Signal Corps in September recorded a continued increase in the neighborhood of 10 per cent over the preceding month, while August was 6 per cent above July and the latter month 17-18 per cent over June.

. . . —

PEAK MONTHS OFF—But unless the rate of increase is sharply accelerated, the needed peak of production to meet the 1943-44 requirements appears several months off. The Navy's Radio Division under Captain Jennings B. Dow has achieved a 50 per cent rise in monthly production, in comparison with last January. But it needs an increase of practically 50 per cent all through 1944 to meet its requirements—and for the anticipated fighting against Japan both in electronic and radio equipment on ships and Naval planes, the step-up in production is vital.

. . . —

CHANGES IN NAVY'S RADIO DIVISION—In line with the traditional desire of a Navy officer to go to sea, Captain A. M. Granum, USN, who has most successfully directed the Radio Division's Installation and Maintenance Branch since November 1, 1942, during the entire administration of Captain Dow, has just been ordered to an important foreign sea duty assignment. He is succeeded by Commander E. L. Fryberger, USN, who has been the Assistant for Ships in that branch for the past few months. Commander S. A. Shephard, USN, is now the Assistant for Ships. Comdr. H. C. Owen, USN, in charge of the Aircraft Radar Section of the Design Branch, also has received his sea duty orders and has been replaced by Comdr. J. F. Mullen, Jr. All these officers are exceptionally qualified in Naval communications and radio procurement with many assignments in radio work both on shore and with the fleet and through their post-graduate studies in communications and radio.

. . . —

POSTWAR PROSPECTS—The U. S. Chamber of Commerce survey of consumer postwar needs within six months after peace comes brought forth the forecast that 2,555,000 families intended to buy radio receiving sets. . . . The School of the Air is certain to grow, with much apparatus to be distributed to educational institutions; FCC Chairman James Lawrence Fly predicts that hundreds of FM stations for educational use can be established on the five FM channels already set aside for that purpose and undoubtedly under the new radio developments educational radio will have a much larger portion of the spectrum. . . . While nothing concrete has yet been decided, the FCC Engineering Department's allocation committee has been making considerable progress on the collection of the basic and essential information for such a step.

. . . —

SIGNAL CORPS DECENTRALIZATION—The decentralization of the Army Signal Corps operations in procurement has now been practically completed with the three field procurement districts having the responsibility for the placement of contracts and the following up of production. The Procurement Districts are Philadelphia under the command of Col. E. V. Elder; Monmouth under Col. Van Ness Phillips; and, Dayton under the command of Col. W. J. Daw. In the following up of production the Procurement Districts will work in the closest sort of coordination and cooperation with the Army-Navy Electronics Production Agency.

. . . —

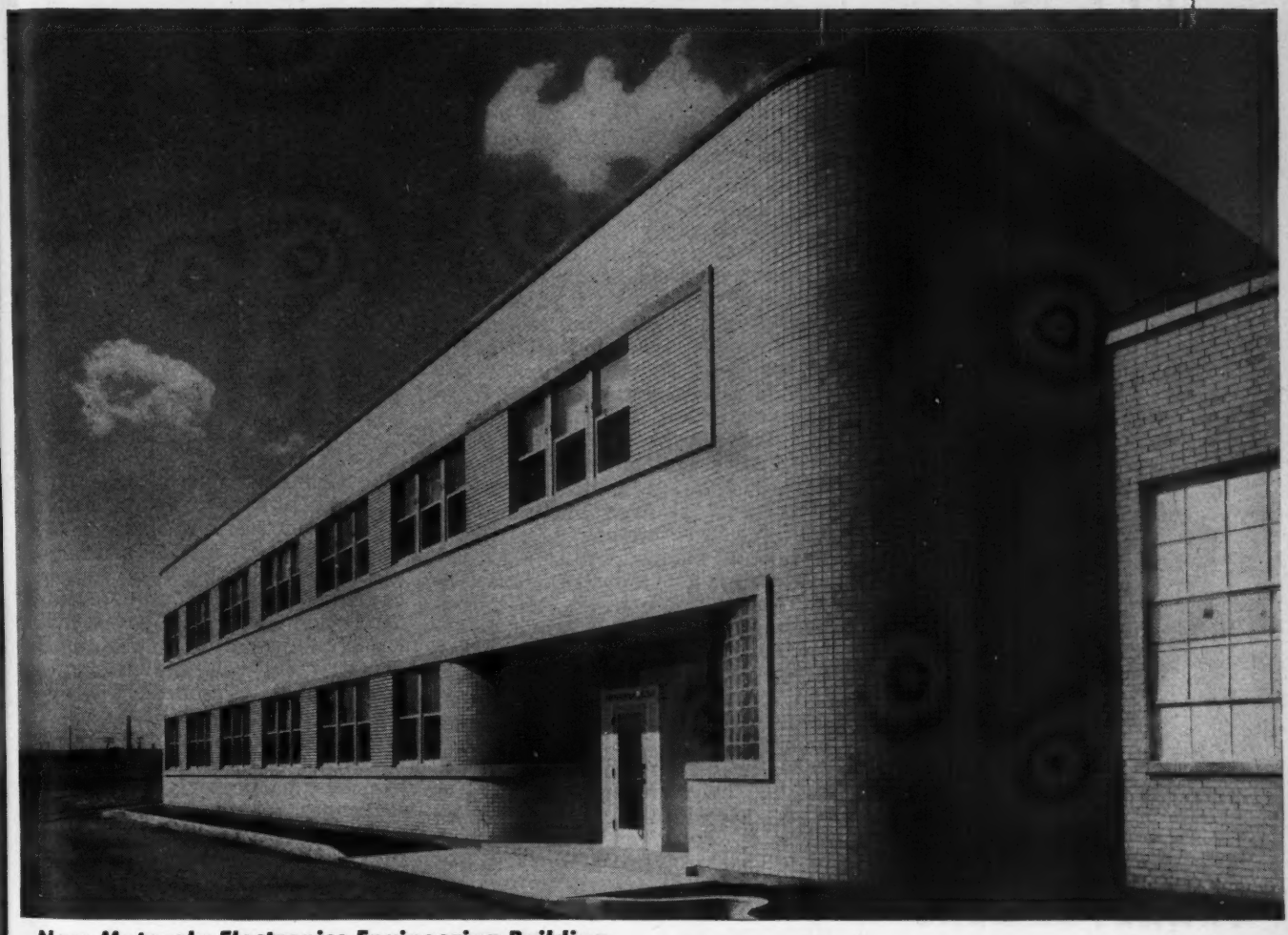
ANEPA STATUS—The status of ANEPA has not been changed and it will continue the activities which have been so beneficial to the entire Signal Corps procurement program. The Procurement Districts will concentrate their production follow-up efforts with the prime contractors and ANEPA will center its functioning more with the component manufacturers and sub-contractors. In the War Department headquarters of the Signal Supply Services, General Harrison has brought in Col. William M. Mack, Procurement Officer of the Wright Field, Dayton, Procurement District to head the Procurement Division. Col. Glenn L. Palmer, who has been acting chief of that Division, is now directing the new Requirements Division which was split off from the Procurement Division.

. . . —

MISCELLANEOUS—WPB Radio & Radar Division's field office set-up is a guidepost for the current WPB decentralization plan. . . . Civilian tube production under Frank McIntosh's direction now is averaging 1,500,000 receiver tubes monthly.

Electronics...

A CHILD WITH A BIG FUTURE



New Motorola Electronics Engineering Building

Another great industry stands at America's threshold . . . and American courage, ingenuity and scientific talents are ready. The new wonders of the Electronic Age stand ready to be revealed to an eager and waiting world.

. . . WITH THE COURAGE OF PIONEERS

Motorola Engineers have faced and solved many important problems in Electronic research and development demanded by the emergency of war . . . and when the time comes, this same tempered and tested brain and brawn will be quickly converted to the needs of peacetime, Victorious America.

You May Expect Important Electronic Contributions from Motorola Engineers. They're in the Making!

The Army-Navy "E" and added Star for excellence in production of Communication Equipment for our Armed Forces.

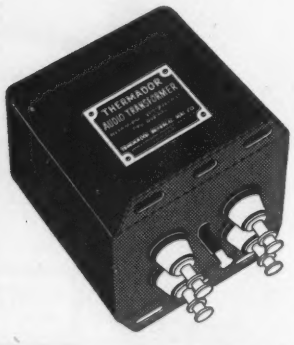
Motorola RADIO
FOR HOME & CAR
GALVIN MFG. CORPORATION · CHICAGO, ILLINOIS

DEFEATS

HEAT

COLD

HUMIDITY



THERMATITE TREATED

THERMADOR TRANSFORMERS

Thermador Transformers are Thermatite treated to withstand extreme temperatures and humidity—arid or moist heat—dry or damp cold do not hamper their efficiency. Thermatite is the name of a process of accurate heat controlled vacuum impregnation developed and improved over a period of ten years.

Thermador also manufactures built-in Electric Heaters, Electric Ranges, Electric Water Heaters.

Policy for Reconversion Set Up in Principle

But manufacturers of electronic materiel still have gigantic task to keep up with military demands

Despite fast-growing military successes, notably the surrender of Italy, the electronics and radio manufacturing industry cannot get to thinking too much about postwar reconversion—the industry, of course, realizes this. The higher production schedules proposed for the remainder of 1943 are "a fresh challenge" to the electronics industry as Director Ray C. Ellis, of the WPB Radio and Radar division, recently stated.

Because electronics equipment is serving as a most important "combatant" in every sector and every phase of the war with ships, guns, planes, tanks and communications all dependent upon the material produced by the electronics industry, Mr. Ellis graphically pictured the production task of the industry. The actual output of military electronics equipment for July was $234,000,000, but as the WPB Director and the Army and Navy authorities have stressed, this figure has to be maintained at $333,000,000 per month to meet the 1943 requirements or nearly $100,000,000 per month more than the July total. The electronics producers "must not relax their splendid efforts if the requirements of the armed forces are to be met," is the admonition of Mr. Ellis.

In the termination of war contracts, the Army and Navy and other government procurement agencies are going to be fair and just. (See the address of Deputy Director Teele, of the WPB Procurement Policy Division, reported elsewhere—Ed.) So far the termination of contracts in the electronics manufacturing field has been greatly different from that in the other branches of munitions production. In general, the terminations have resulted from the cancellation of particular models and types of equipment with the substitution to the same contractor of newer and more modern electronic devices.

Transition principles

The policies of reconversion of the radio and electronics industries back to peacetime operations have not yet been evolved in any detailed or specific form—because the Washington authorities, both in the armed services and in the WPB, are naturally devoting their entire efforts toward "getting on with the war" to achieve final victory. But the machinery has been set up in a broad form for the gradual transition from military to civilian production as the requirements of the armed services drop off. Limitation orders are framed and geared so that this gradual conversion to civilian production can take place. An analysis of these orders reveals that the operations of most companies are being regulated on the pattern or code type of operations rather than upon the more regimented specific handling of detail production requests from the services.

When peace comes, there will be a flood tide of demand for civilian uses of the electronic developments of the war, now shrouded in military secrecy. This, it is well known, will arise from all fields—broadcasting, communications, aviation and marine navigation and safety, and a myriad of industrial uses. Thus, the transition back to peacetime production will be greatly implemented.

Protecting Essential Plants

To aid in the protection of the nation's important war facilities and resources from destruction by enemy activity or any other forces likely to interrupt production, WPB has announced the establishment of a Resources Protection Division and the continuation of the Resources Protection Board. The Board determines the relative importance of plants, facilities, installations, and other economic resources to the war program from the point of view of protection against all hazards. The Division will advise appropriate agencies, particularly the industry and materials division of the WPB and the Army-Navy Munitions Board, with regard to the allotment of materials and equipment for the protection of facilities.

Class A Product Allotment Procedure Modified

Manufacturers of Class A products have the right to ask for allotments from their customers for the quarter in which the allotments are needed to obtain delivery of controlled materials, the War Production Board has ruled in issuing Direction No. 27 to CMP Regulation No. 1.

If the manufacturer is asking for an allotment to replact inventory of controlled materials which he will use in the manufacture of the Class A product, he may ask for it in the quarter for which the order is placed or for any of the next three quarters. Manufacturers do not have to accept orders for such products, unless their requests for allotments, within the specified time limits, are complied with.

Manufacturers, however, must not ask for allotments for quarters

BETTER BANK ON THE *HUMAN* ELEMENT, TOO

In the excitement of electronic discoveries and predictions, one great and important factor—the *human* element—stands forlorn. Machines and uses are, after all, only the offspring of man's experience and ingenuity. The more capable the man, the more dependable his product.

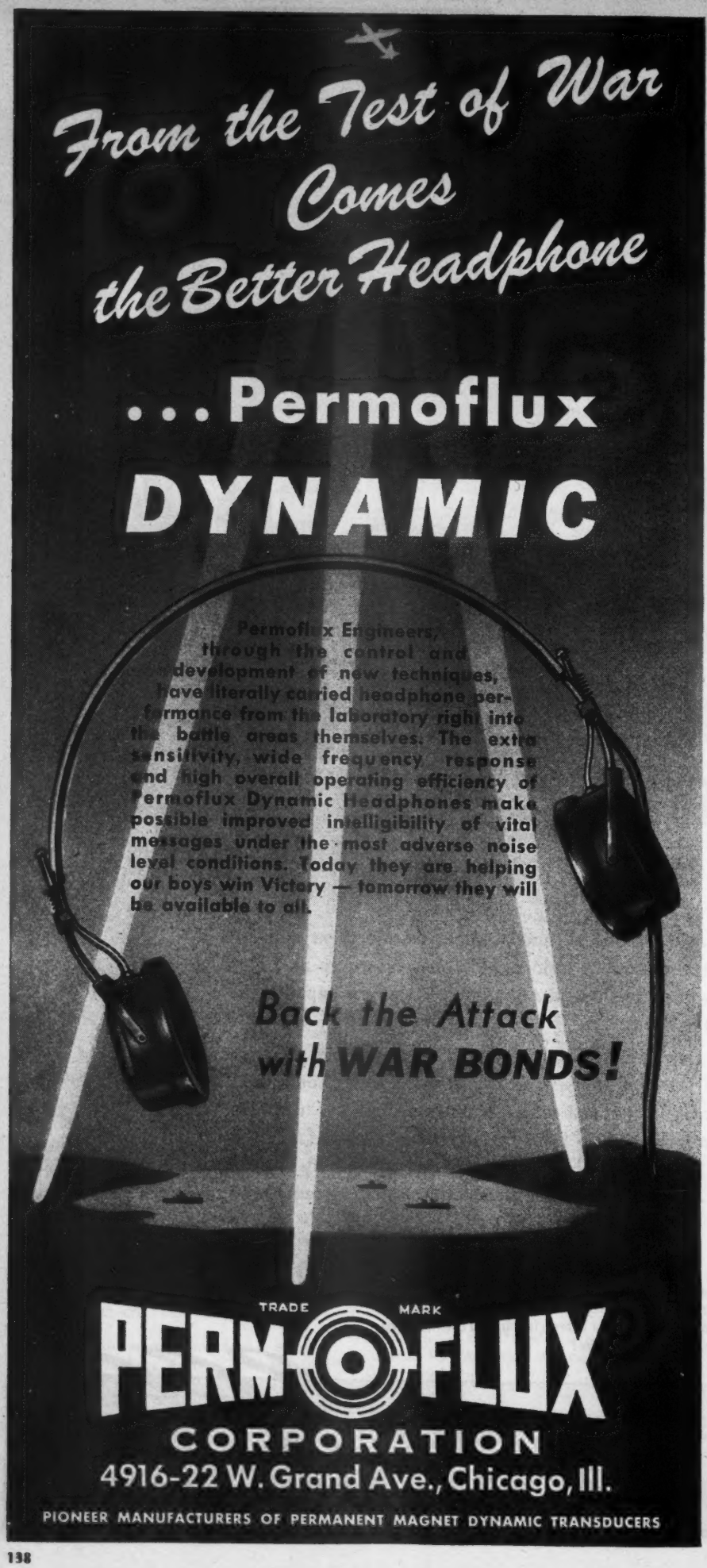
This is the *human* element upon which the Electronic Corporation of America places a high evaluation. And this, we suggest, is the element you should seek when planning your future program. Find out more about your man and his background. Is he an old-timer or a "war baby"? Does he have the ability and facilities to produce? How high are his standards? These are questions we'll gladly answer. We're 100% in war work now . . . but, occasionally production schedules enable us to accept additional contracts . . . *communicate with us.*

A CALL FOR GREATER EFFORT . . . *The WPB reports that war production has fallen off considerably. This is a challenge to industry and labor, and it's up to us to find the reason, whether it be optimism, internal strife, working conditions, discrimination, etc. The roar of battle is thousands of miles away, but, if you listen closely, you can hear the screams of a dying soldier. Can it be because we failed him?*

ECA

ELECTRONIC CORP. OF AMERICA

45 WEST 18th STREET • NEW YORK 11, N. Y. • WATKINS 9-1870


From the Test of War
Comes
the Better Headphone
...Permoflux
DYNAMIC
Permoflux Engineers, through the control and development of new techniques, have literally carried headphone performance from the laboratory right into the battle areas themselves. The extra sensitivity, wide frequency response and high overall operating efficiency of Permoflux Dynamic Headphones make possible improved intelligibility of vital messages under the most adverse noise level conditions. Today they are helping our boys win Victory — tomorrow they will be available to all.
Back the Attack
with WAR BONDS!
TRADE MARK
PERMOFLUX
CORPORATION
4916-22 W. Grand Ave., Chicago, Ill.
PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

in which they cannot accept delivery of controlled materials because of inventory limitations.

Interpretation No. 11 to CMP Regulation No. 1 indicates that a manufacturer of Class A products must fill orders out of excess stocks if the size of his inventory prohibits its acceptance of delivery of controlled materials. Nevertheless a manufacturer may insist on an allotment before accepting an order for a Class A product, if the quarter for which he is seeking the allotment is within the time limit permitted by Direction No. 27.

Four procedures

Manufacturers of Class A products operating under the Controlled Materials Plan may, instead of making allotments to their suppliers, follow any one of four procedures, if their suppliers consent, the War Production Board pointed out today. Such a manufacturer may use any one of the following alternatives:

1. He may sell the material to his supplier from his own inventory.
2. He may furnish the material to his supplier on toll or processing agreement, retaining title in himself.
3. He may place an authorized controlled material order for delivery to himself and trans-ship the material to his supplier, either by sale or under toll or processing agreement.
4. He may place an authorized controlled material order for delivery directly to his supplier.

Allotment records

In none of these cases does the customer make an allotment, and the supplier does not have to keep any allotment records. The supplier must, however, keep records to show that he is using the material for the purpose for which it was received.

Customers furnishing the material must include it in their own requirements in applying for allotments in the same way as if he were going to allot it. He may not furnish controlled material to his suppliers except under conditions where he would be able to make an allotment under the terms of CMP Regulation No. 1. Consequently, the four procedures may not be used to make allotments to producers of Class B products, unless special permission to do so is obtained from WPB, since under paragraph (g) of CMP Regulation No. 1, consumers may not make allotments to Class B product manufacturers. Class B product producers ordinarily receive their allotment from WPB.

PROTECTED

against excess anode Temperature

through the use of graphite anodes . . . pioneered for the industry by our engineers.*

Experienced heads, which among other things pioneered the graphite anode and the carburizing of thoriated filaments, have joined in this young and virile company to develop and manufacture the finest in vacuum products for electronic applications . . . with no prejudices, no preconceptions, no antiquated equipment or methods to hinder their creative and productive abilities.

This tube, type DR300, is a typical example of these skills. It is a rugged tube for rugged service with a plate dissipation of 300 watts. Severe service tests in high frequency furnaces have consistently proved this tube superior.

Inquiries are invited.

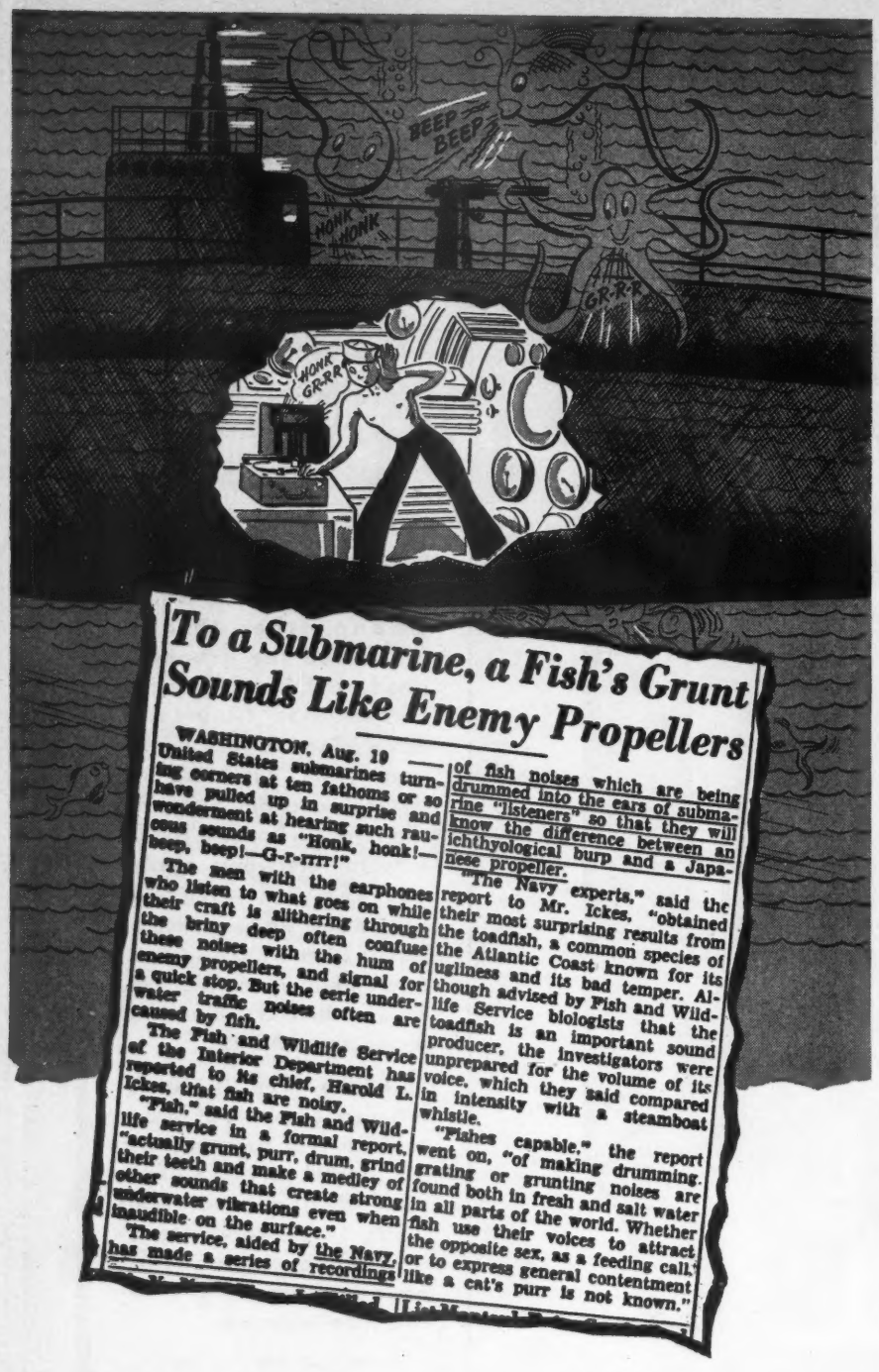
ESPECIALLY ADAPTED FOR HIGH FREQUENCY BOMBARDERS

*We refer persons interested in this pioneering work to an article by D. E. Replogle which appeared in the December 1933 issue of Electronics, pages 338, 339.

GENERAL ELECTRONICS INC.

101 HAZEL STREET, PATERSON, N. J.

SPECIALISTS IN ENGINEERING AND MANUFACTURING VACUUM PRODUCTS FOR ELECTRONIC APPLICATIONS



To a Submarine, a Fish's Grunt Sounds Like Enemy Propellers

WASHINGTON, Aug. 19 — United States submarines turning corners at ten fathoms or so have pulled up in surprise and wonderment at hearing such raucous sounds as "Honk, honk! beep, beep!—G-r-rrrr!"

The men with the earphones who listen to what goes on while their craft is slithering through the briny deep often confuse these noises with the hum of enemy propellers, and signal for a quick stop. But the eerie underwater traffic noises often are caused by fish.

The Fish and Wildlife Service of the Interior Department has reported to its chief, Harold L. Ickes, that fish are noisy.

"Fish," said the Fish and Wildlife service in a formal report, "actually grunt, purr, drum, grind their teeth and make a medley of other sounds that create strong underwater vibrations even when inaudible on the surface."

The service, aided by the Navy, has made a series of recordings of fish noises which are being drummed into the ears of submarine "listeners" so that they will know the difference between an ichthyological burp and a Japanese propeller.

"The Navy experts," said the report to Mr. Ickes, "obtained their most surprising results from the toadfish, a common species of the Atlantic Coast known for its ugliness and its bad temper. Although advised by Fish and Wildlife Service biologists that the toadfish is an important sound producer, the investigators were unprepared for the volume of its voice, which they said compared in intensity with a steamboat whistle.

"Fishes capable," the report went on, "of making drumming, grating or grunting noises are found both in fresh and salt water in all parts of the world. Whether fish use their voices to attract the opposite sex, as a feeding call, or to express general contentment like a cat's purr is not known."

Over land and under sea, Presto Recorders have their ears glued to Sounds . . . pick them up and play them back so Sailors, Soldiers and Aviators may *know* who's there—friend or foe! • As in peace, so in war . . . if it's a noise Presto will get it—faithfully and realistically.

Presto Recording Corporation

NEW YORK 19, N. Y., U. S. A.

World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs

1943 Broadcasting, $215,000,000

In response to our request for an advance figure on the total volume of business of U. S. broadcasting stations for 1943, Sol Taishoff, editor of "Broadcasting," Washington, D. C., kindly sends us the following "rough estimates."

Total net time sales (gross billings less promotional discounts) $215,000,000 in 1943, as against $191,000,000 in 1942.

Gross time sales (the one-time rates projected) $280,000,000 in 1943, as against $254,800,000 in 1942.

"There are no accurate figures on talent sales, but they run between $40,000,000 and $45,000,000 annually," writes Editor Taishoff.

G. E. Conference Reviews Electronic Achievements

Reviewing industrial electronic principles and art, General Electric Co. staged a conference middle of September in Schenectady, birthplace and proving ground of many significent developments in the science of electronics.

Speakers at the conference were: L. A. Umansky, assistant manager of G. E.'s industrial engineering division, who spoke on the broad aspects of industrial electronics; W. C. White, engineer of the electronics laboratory, who told of the variety and types of electron tubes available for industry; L. W. Morton, of the industrial engineering division, who covered electronics in power conversion and frequency changing; W. C. Hutchins, manager, special products division, who told of the application of electronic measuring equipments; J. P. Jordan, electronics section, industrial heating engineering division, described electronic heating; and E. H. Alexander, engineer, industrial control division, discussed electronic controls. W. C. Yates, assistant manager, industrial division, presided.

Brazil Radiophoto Service

The first radiophoto service between the United States and Brazil was inaugurated on September 7 and operated by the Mackay Radio and Telegraph Co., an associate of I.T.&T. In Brazil the operating unit will be the Companhia Radio Internacional do Brasil at Rio de Janeiro. Opening of the service was coincident with and marked the celebration of the Brazilian Independence Day. The service, which was arranged through the cooperation of the Coordinator of Inter-American Affairs, will provide for the international transmission of radiophotos under the name "Mackay Radio-Radiophoto Service."

And Then there were Two!

Copyright 1943—Philco Corporation

This is another of the series of cartoon advertisements appearing in the national magazines depicting the might of industrial America. It tells the story of Philco at war and the peacetime promise of Philco war research and production for the homes and industries of America.

AS OUR fighting forces move to the attack, there is one assurance that the home front may safely draw from the news. No power on earth can match the productive might of an aroused industrial America! That is the faith that gave us the courage to go forward during the darkest days of the Axis advance. And that is the calm conviction that leads us today to bend our full strength to the task until total victory is won.

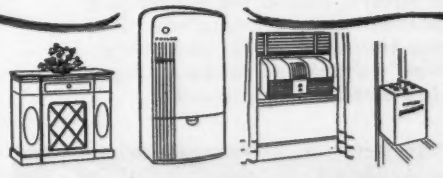
The men and women of Philco know that whatever toil and sweat it has taken to win the initiative, it will take more of the same to win the Victory. All they have learned in their laboratories and production lines during twelve straight years of radio leadership is devoted now to making radios, communications and electronic equipment that will give our soldiers and sailors superiority in the attack.

On some tomorrow, they will be back at their peacetime tasks, bringing you the fruits of their new knowledge and skill in radio, television, refrigeration, air conditioning and industrial electronics . . . under the famous Philco name.

PHILCO CORPORATION

In time of War

BUY BONDS FOR VICTORY



PHILCO—the Quality Name in Millions of American Homes.

In time of Peace

BUY PHILCO FOR QUALITY

Any Frequency to 500 K C.

When your job calls for efficient filters you can depend on ADC to produce well-built, compact units to suit the most exacting requirements. From the moment your specifications are received, until production is actually complete, your particular problem becomes the immediate concern of our competent design engineering staff. Years of research and specialized experience is behind every ADC Filter.

ADC Filters are especially adapted to Aircraft, Marine, Portable and Stationary installations. They can be readily designed for high pass, low pass, band pass and band rejection, or for combinations of these to obtain several pass and attenuation bands. Too, you may be advantageously able to use an ADC Filter designed for impedance transformation — for example, from line to grid.

If you want the ultimate in advanced engineering, maximum efficiency and rugged mechanical design, you will do well to consult with us.

In addition to filters, Audio Development Company manufactures a complete line of specialized transformers, reactors, equalizers, key switches, jacks, plugs and other electronic equipment.

ADC

Audio Development Co.

2833 13th Ave. S., Minneapolis, Minn.

SURVEY OF WIDE READING

(Continued from page 107)

second pulses at a rate of 50 per second so that the components could be received as a succession of pulses each characterized by its time-delay, intensity and angle of incidence.

Time-delays and intensities of these components were found by applying only one antenna output to the cathode ray oscillograph, a synchronized linear time base being connected with the other pair of plates. For angle-of-incidence determinations the linear time base was replaced by the other antenna output, the number of distinct separate ellipses observed being equal to the number of separate pulses observed with the first connection.

Results obtained during an eight month period are tabulated, graphically shown and discussed. They indicate single and multiple layer reflection from E and F layers and are in satisfactory agreement with theoretical expectations. Influence on the F-layer reflection by passage of the waves through the intervening E-layer is studied.

It is stated that in the absence of intervening layers, a knowledge of the state of the ionization of the ionosphere, the operating wavelength, the characteristics of sending and receiving antennas, etc., can be used for making reliable predictions of the type of propagation that may prevail in the case of short-distance short-wave propagation.

On Oscillations in Resonant Cavities

M. M. Jouguet (Revue Generale de L'Electricite, Paris, Vol. 51, No. 6, 1942)

The mathematical problem of a resonant cavity bounded by a surface of revolution and consisting of a perfect conductor is treated. General solutions for geometrically simple cavities are derived, as well as particular solutions having symmetry of revolution for a cavity with arbitrary meridian. To illustrate the method, it is applied to spherical resonators, and oscillations having symmetry of revolution are considered in more detail.

Iron-Core Coil Circuits

K. O. Friedrichs and J. J. Stoker (Quarterly of Applied Mathematics, July, 1943)

Periodic solutions of the differential equation $\frac{d^2x}{dt^2} - f(x) = F \cos wt$, in which $f(x)$ is a general nonlinear function of x, are discussed. Such differential equations may oc-

JAMES KNIGHTS *Crystals*

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JK CRYSTALS

DO YOU NEED THESE TYPES!

- ★ 100 KC. coated bars—3 PPM or less per 0° Centigrade. (Other frequencies: 50 KC. to 200 KC.)
- ★ 1000 KC. precision metal tube mounted crystals
- ★ Bertrand plates
- ★ 20-23 Atomic plane standards

Precision production now available on the above special quartz products. Tell us your requirements on these or other crystal types which we may be able to supply.

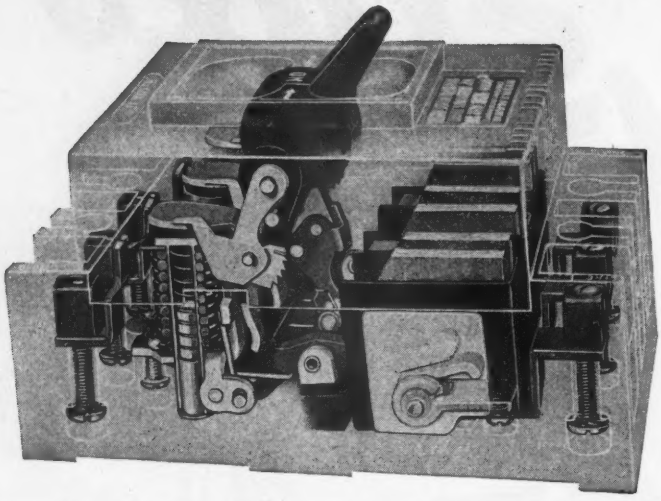
PRECISION CUTTERS OF QUARTZ
for
COMMUNICATIONS & OPTICAL USES

Any Type, Cut or Frequency

The JAMES KNIGHTS Company

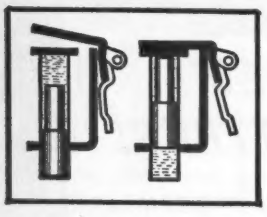
SANDWICH, ILLINOIS PHONE 65

All 3 contribute to the High Efficiency of



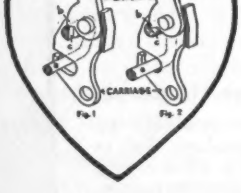
HEINEMANN

MAGNETIC CIRCUIT BREAKERS



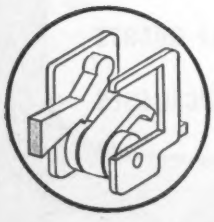
TIME DELAY ON OVERLOADS

The magnet coil surrounds a hermetically sealed, liquid filled cylinder containing an iron plunger which, while normally out of the magnetic field, moves into it on overloads, the liquid controlling the speed. As the plunger rises to the top of the cylinder, the magnetic flux increases to its maximum. At this point the armature is attracted to the pole piece.



HIGH SPEED LATCH

The armature on engaging the lower leg of the lock (a) rotates it so that the tooth of the catch (b) passes through the cut portion of the lock (c) and opens the contacts. *Of all known latches, this one acts with the least amount of friction and mechanical delay.* The latch collapses only on short circuit or overload conditions even if the handle is purposely held in the "on" position.



HIGH SPEED BLOWOUT

The stationary contact is coiled around an insulated iron core connecting steel plates to form a U-shaped magnet. On overloads and short circuits the current flowing through the contact creates magnetic lines which force the arc into the arcing chamber and blow it out. As the value of the current to be interrupted increases, the quenching effect becomes greater due to the intensified magnetic blowout field.

HEINEMANN CIRCUIT BREAKER CO.

137 PLUM ST. - - - TRENTON, N. J.

cur in problems when iron is contained in the magnetic circuit.

Various ways of finding approximate solutions by iteration and perturbation methods are described. Qualitative results are graphically shown and the physical behavior of the corresponding circuits explained. Particularly, jumps observed in the amplitude of forced oscillations are considered. It is shown that for a slow variation in the frequency w of the applied force and for its amplitude being held constant, the formulas indicate the observed jump. Conditions for the generation of subharmonics are investigated.

Electric Circuits Equivalent to Electromagnetic Fields

Gabriel Kron (Physical Review, August, 1943)

The possibility of constructing distributed-constant networks representing Maxwell's equations is pointed out. In these systems, electric and magnetic field components would correspond to voltages and currents in the three dimensional network. A network equivalent to a charge-free space with given permeability, dielectric constant and conductivity is illustrated.

On the Theory of Vacuum Tubes

J. H. Fremlin (Electronic Engineering, London, August, 1943)

Essential tube characteristics and their relations to the basic laws of physics are the subject of the article. Considerations are given to the inaccuracies of the approximations used. Equivalent diodes are discussed. The method of experimenting with a rubber sheet, obeying a law mathematically identical with Laplace's equation, to obtain the potential distribution in tubes is explained.

Emission-Type Phototube

A. C. Lynch and J. R. Tillman (Post Office Electrical Engineers' Journal, London, July, 1943)

A general characterization of emission-type photoelectric tubes, as distinguished from either conductivity or barrier-layer tubes, is given. The properties of vacuum cells, gas-filled cells and secondary emission cells are compared; the influence of applied voltage is shown in the figure.

An emission-type phototube is equivalent to a high impedance source shunted by an interelectrode capacity of the order of 5$\mu\mu$F. Short accounts are given of sensitivity, linearity of response,

OHMITE *Catalog "40"*

Your "Answer Book" to Resistance Problems

Electronic Engineers everywhere have been using Ohmite Catalog "40" as their guide-book on resistance problems. They have found it an indispensable source of information. Its 96 pages are packed full of helpful engineering data, dimensional drawings, useful reference tables, charts, and a manual of resistance measurements. Catalog "40" gives details on the wide range of Ohmite types and sizes in resistors, rheostats chokes, tap switches and attenuators . . . both stock and special units . . . for all types of applications in the Armed Forces and in Industry. Catalog "40" explaines how to select the right units for each need. It can help you in designing new devices for a new tomorrow. Ohmite Engineers are glad to work with you.

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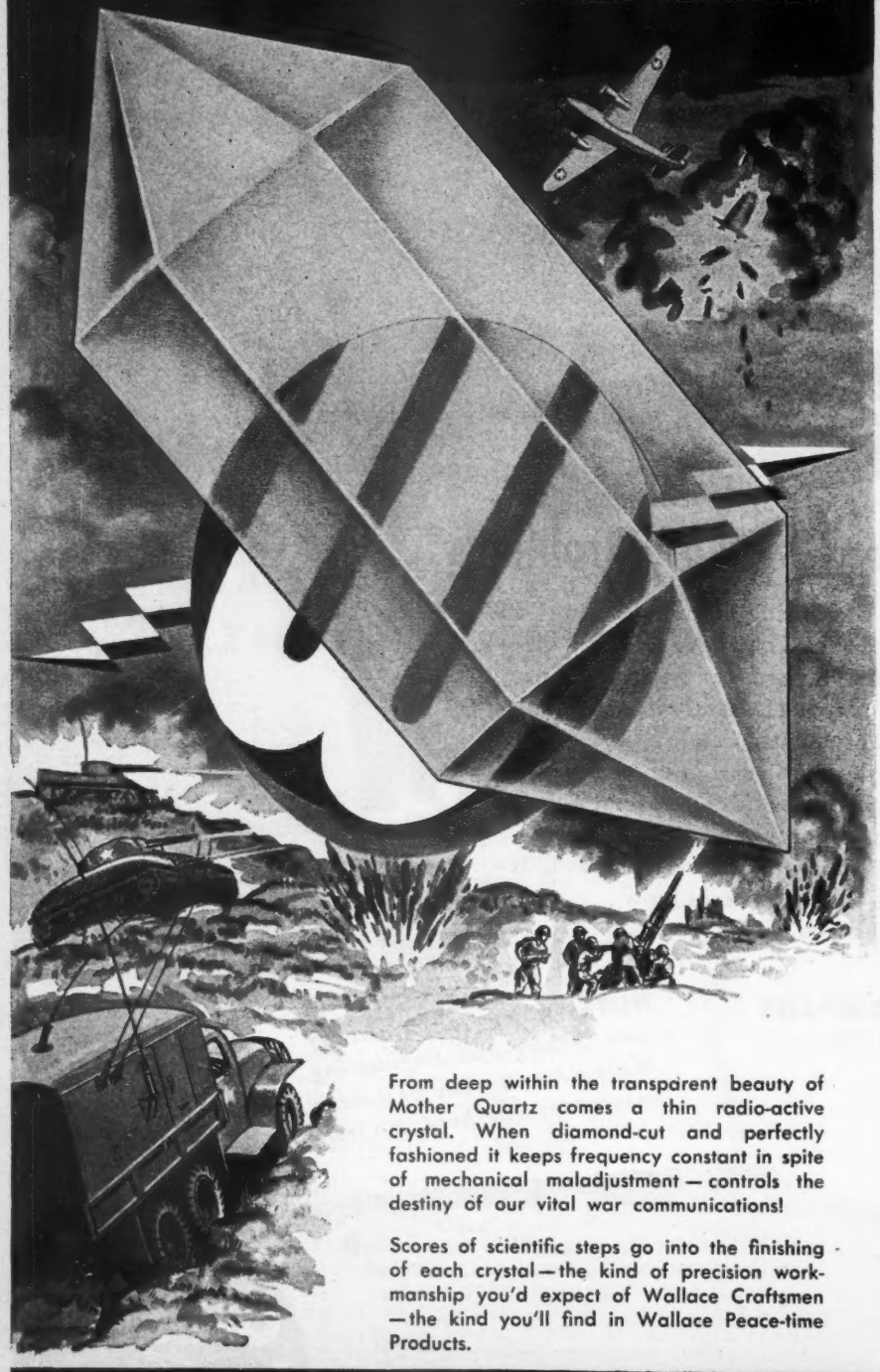
DESTINY *in a Rock*



From deep within the transparent beauty of Mother Quartz comes a thin radio-active crystal. When diamond-cut and perfectly fashioned it keeps frequency constant in spite of mechanical maladjustment — controls the destiny of our vital war communications!

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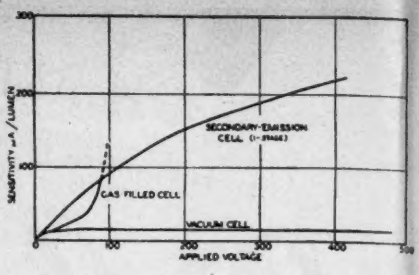


Emission type phototube

color response, frequency response to interrupted light, and life of the different tube types. Simple diagrams of the most frequently used circuits are included.

Computing UHF Radiation

Andrew Alford (Electrical Engineering, August, 1943)

Formulas are derived for computing the radiation pattern of an uhf antenna when the field distribution in the immediate vicinity of the antenna is known. The method used involves finding electric and magnetic current and charge distribution equivalent to the known field in the vicinity of the antenna and then evaluating the resulting electromagnetic field distribution in space. To illustrate the method, the radiation from the open end of a concentric transmission line is calculated.

Tube Voltmeter

M. Kuferberg (Review of Scientific Instruments, August, 1943)

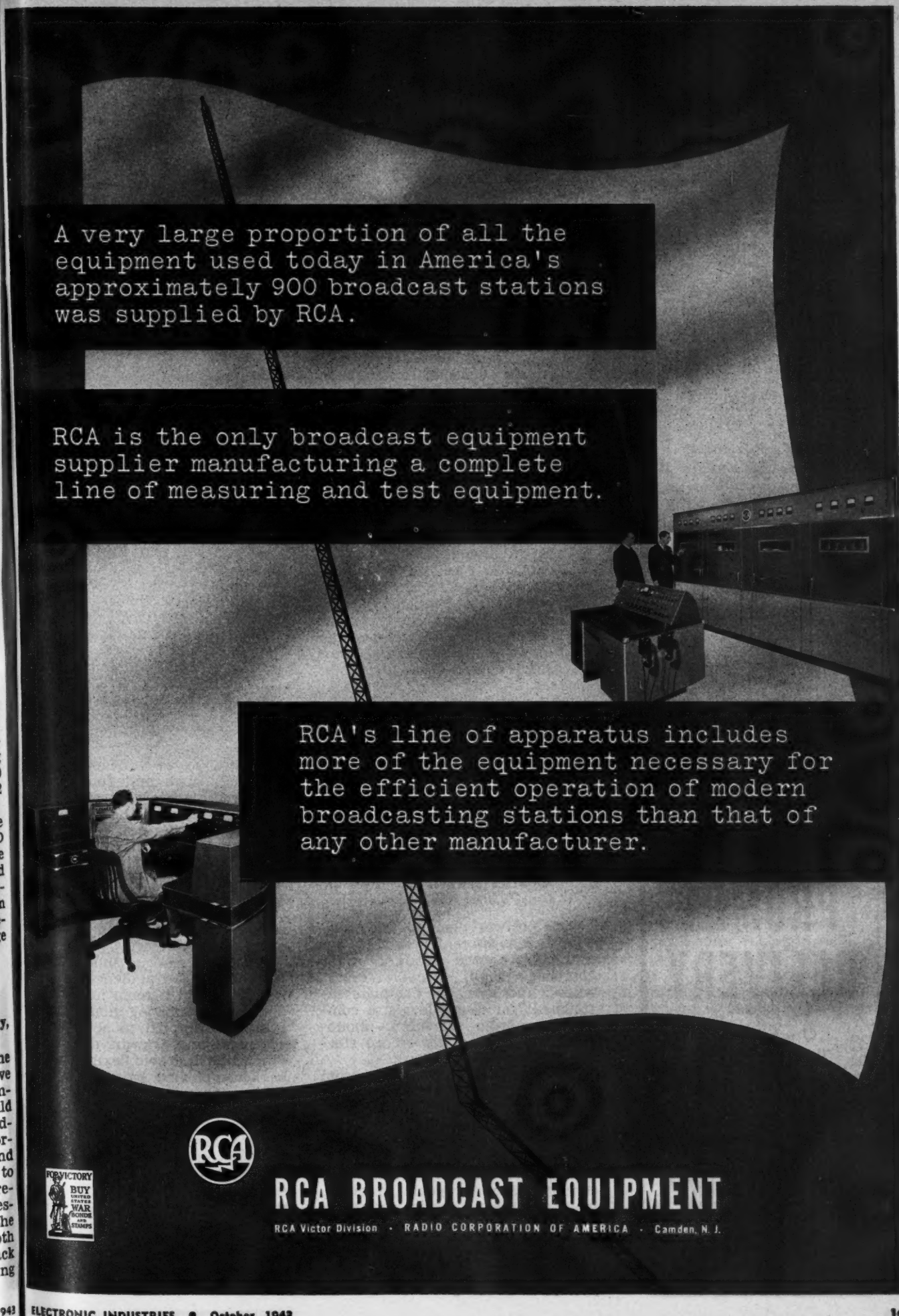
The vacuum-tube voltmeter described is intended for measuring negative voltages from 0 to 5,000 volts with a maximum error of 2 per cent.

The circuit makes use of the plate of a Western Electric 211D tube as the input for the negative voltage. A milliammeter in the grid circuit indicates the negative voltage applied. The circuit diagram is shown and its performance described. Grid current-plate voltage characteristics are included.

On Negative Feedback

J. T. Terry (Wireless World, July, 1943)

Several postulates regarding the effective application of negative feedback are explained by examples. Obviously, feedback should be truly negative. Further, feedback can correct frequency distortion in voltage amplifiers if, and only if, the distortion is not due to series resonance. It is also required that the distortion be present at the input terminals of the feedback network and that both the amplifying and the feedback path be able to pass the correcting voltage freely.


A very large proportion of all the equipment used today in America's approximately 900 broadcast stations was supplied by RCA.
RCA is the only broadcast equipment supplier manufacturing a complete line of measuring and test equipment.
RCA's line of apparatus includes more of the equipment necessary for the efficient operation of modern broadcasting stations than that of any other manufacturer.
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Manufactured in accordance with the requirements of the War Standards Committee specifications, including nine cycles of the salt water immersion test. Results of the New York Testing Laboratories, Inc., tests are available on request.

Normal operating temperature is 160°C with a large safety factor permitting high overload. Resistors are available in sizes ranging from 2 to 80 watts with either ferrule or radial tab terminals. Resistance values up to 75,000 ohms using 0.0025" wire or 270,000 ohms using 0.0015" wire are standard.

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POSTWAR RADIO SETS

(*Continued from page* 84)

Simultaneous Programs

by **EGMONT ARENS**
480 Lexington Avenue, New York, N. Y.

As I see it, the most universal need in the average radio home is some sort of a system whereby various members of the family can all hear their favorite programs without interfering with other members of the family.

At the present time there is usually more than one radio in the house, and so people go to various rooms in the house and listen to their programs, but this creates rather an unsocial environment with everyone scattered to different rooms.

It seems to me that this problem should be recognized with a system of radio installations which would make it possible for persons in the same room to hear different programs by use of ear phones.

The ideal method would be to have a series of radio sets installed in tandem or triplicate or quadruplicate, according to the number of radio fans in the family, and wall plugs inserted in convenient locations so any one could hook in to any one of the programs that was playing. The system would, of course, include a loud speaker so that if all wanted to listen to the same program, they could do so.

If a research were made into the radio-listening habits of America, one would find that this is an outstanding problem, and I believe it could be solved in a manner which would create a lot of radio sales.

Music Lovers' Instrument

by **GUSTAV JENSEN**
16 East 48th Street, New York, N. Y.

The postwar demand for radios will, I believe, center around two main types, the straight radio, compact, small, placable everywhere, and then the complete instrument for music lovers, a combination radio - television - phonograph, with space for record storage.

We realize today that room beauty depends not only on the things we put in them but equally on the space between them. We have become conscious of space as something pleasant in itself. Yet modern development, increasing concentration of people in cities, inevitably means smaller rooms. So we must have things compact in order to have beauty and order in our homes. Convenience in use and ease in keeping clean are important factors, the dial, i.e., offers opportunities for development that have not yet been explored.

With television, radio comes into maturity and there is some hope for the stabilization of the instrument as such and hence the evolving of a standard design of general acceptance, such as the piano and other musical instruments.

Plastics, which the war has so vastly developed, will be the material because it gives us, to a higher degree, what wood and metal possess at a fractional cost. It will satisfy our demand for modern smooth elegance and, for that other human requirement of variety, it will satisfy that with its endless range of colors and textures, opaque, translucent, transparent.

Flexibility Essential in Design

by **CHARLES F. DREYER**
300 Hayward Avenue, Fleetwood, N. Y.

Design will play its helpful part in the plan for the future. The radio and television cabinet will be an engineered housing with its function its first consideration. With postwar home planning there may well be a need for "Packaged Radio": — the elements of radio divided into easy-to-arrange flexible units of amplifiers, power supply, and speaker so the professional planner or capable hobbyist could design his home with sympathetic regard for his own demands of convenience, taste and function. An improved remote control is necessary and perhaps the inclusion of a speaker in the unit which might be beamed to a narrow "hearing cone" for the comfort of those not desiring to listen. A maximum volume limiter could be made for the loud-radio addict. Television in remote control units could be applied to the nursery.

Television screens should be adjustable to the audience in order not to disrupt a room in the usual manner of showing home movies. I have attempted to show in the accompanying drawing one way in which this desirable flexibility could be accomplished by use of a revolving turret screen (direct-on-tube-vision) with consideration of practical engineering limitations of present day equipment.

Sound-on-film or sound-on-wire is desirable for its continuity and compactness. Plastic-bonded plywoods are recommended for ease in manufacturing the reverse curves of this turret form as well as for their inherent qualities of lightness, strength and durability. I am aware of the possibilities of televi-

THE war record of America's radio tube engineers is an impressive one. Yet these able and ingenious men, too, have their "problem children".

In this category are the miniature tubes used by our combat troops in communication radio sets. Admittedly these tubes are tough little "hombres" — especially "tough" for that selected group of engineers whose responsibility is to produce them by the tens of thousands. Only because of the sweat and tears of these men has the flow of miniatures to our armed forces been maintained and steadily expanded month after month.

That National Union is one of the nation's important manufacturers of miniatures is evidence of the success of N.U. engineers in helping to solve one of this Industry's most difficult war production problems. Thus do research and development experiences in wartime build a reservoir for post-war accomplishment. Whenever problems involving vacuum tube design and application press for solution, look to National Union engineers for the answers. Learn to *count on* National Union.

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If we haven't what you want in stock, we'll find it for you as fast as wartime conditions permit.

Telephone Orders to BRYANT 9-1946

HARVEY RADIO COMPANY

103 WEST 43 ST. NEW YORK, N.Y.

sion-by-projection and beautifully built-in-wall screen and set installations but these seem limited to the custom built house. My idea would be to take television and radio equipment and develop a unit with all the flexibility and compactness possible, in a price range saleable to the largest possible market.

After the first postwar turmoil of satisfying the vital need of getting into production with prewar models with minimum delay, design, in keeping with modern technological advances, functional principles, artistic soundness, and sales incentiveness, will continue in its proper place in all industry as a guide to better humaneering.

A Step-by-Step Design

(*Continued from page* 84)

making the designer a real part of the production in order to achieve higher standards in both production and design.

Realizing some of the implications of the above tasks, I have been led to the suggestion illustrated here of a "Unit Radio Design."

The radio cabinet might be considered as formed by three basic units. This would simplify fabrication and help to lower the cost of mechanical equipment.

The consumer, in turn, would benefit by a "step-by-step" purchase plan, each step giving him the best workmanship and performance available. Thus, he might start by owning the best radio-television unit to be found on the market and finally own a complete "radio-television-symphonic record player" unit, without having to pay, right at the beginning, the high initial cost of such a combined unit.

This approach, based on modern furniture design concepts, combining beautiful materials with fine workmanship and eliminating all unnecessary and dust-catching ornamental gadgets, moldings, etc., might result in the creation of an economical entity that would fit harmoniously with the cabinets, bookshelves and furniture already owned by the consumer.

Postwar Design

(*Continued from page* 84)

fact that newly developed improvements are part of the radio set. Visual emphasis will again be given to the super-technical aspects of the radio. The point reached by radio at the beginning of the war, sought to obscure the technical aspects in furniture-type cabinetry, because of such slight differences between competitive sets. Manufacturers who plan to give consumers every technical advancement may devise ways to make this fact visually evident in the appearance of their brand of radio sets.

Consequently, radio for the average consumer may have a more mechanical-appearing exterior—to indicate superior performance features. This may give the radio industry the opportunity to make the radio set look exactly the way it should look—like a radio set and not as a dressing table, lamp stand or other less important accessory.

This point of view may aid the radio industry in producing sets of fine performance, to sell at worthwhile prices. In doing this the radio business can rise above the cut-rate drugstore and pee-wee type product.

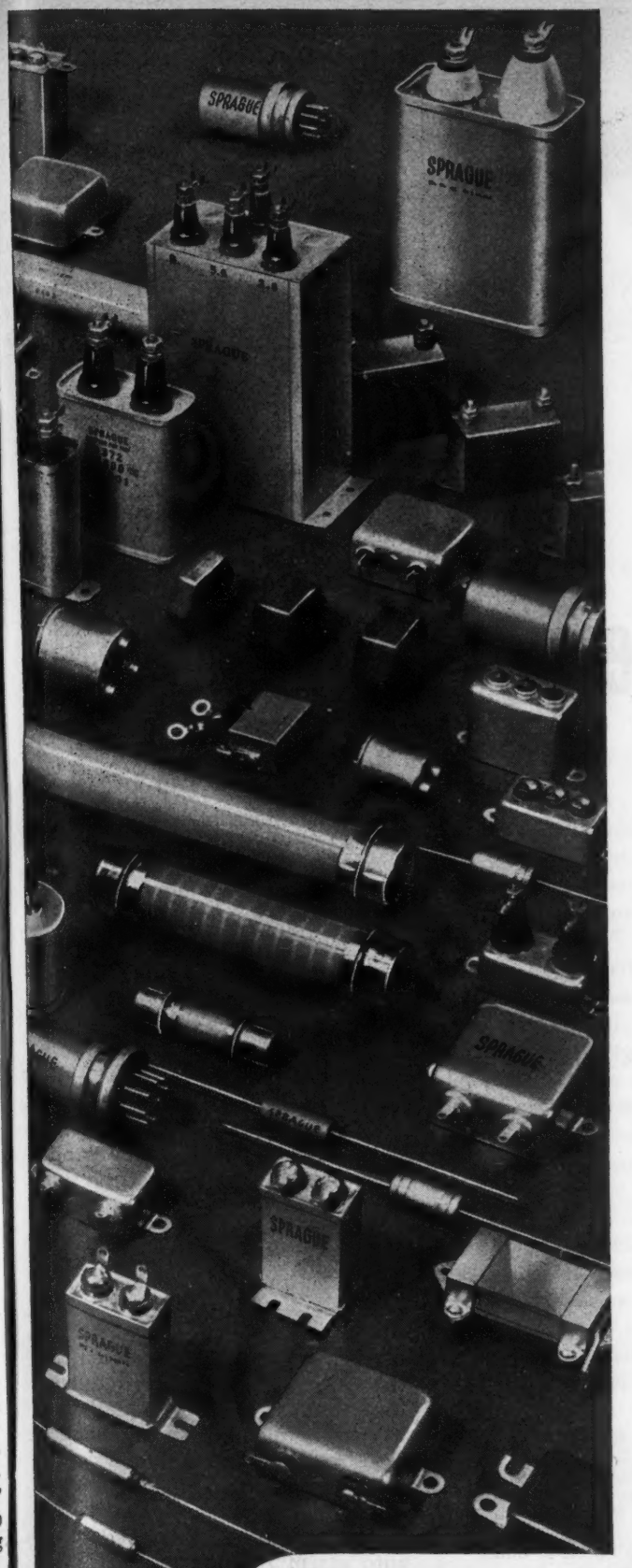
2. The way radio sets are distributed and sold will strongly influence their new character. Are they to be retailed as packaged merchandise as in the past, or will their new highly improved technical character demand selling through specialized service type outlets? Will installation and service become more important than was necessary with the former ordinary set?

Will the combination of radio, phonograph, television and electronic developments require more skilled technicians to sell and service future radios? If this takes place, the aspect of the cabinetry will be something never before seen in radio, and if well done, along these lines, a good radio can earn a high unit selling price.

3. The vast small-home building program which will follow the war is certain to influence the general character of the radio set. Will manufacturers develop a new type set to build into every new small home or will they continue to make radio to sell as a separate piece of room furniture?

It would appear that the war and the consumers' dependence upon the radio for war news and personal protection against air raids has made radio become more than an incidental household item—to have or not to have. Having become a necessity, it will take on the same importance in home building as the electric light system or the built-in bath tub. Radio manufacturers might well consider meeting this "home-builder" market and develop built-in radio cabinetry to meet this oncoming need.

At one time stoves, gas ranges, tubs, refrigerators, etc., were sold as separate items, to be placed in whatever space might be available. Today, the home is built around these operating essentials. Radio has achieved this point of "essentiality." Its entire makeup may be keyed to take advantage of this fortunate circumstance—and en-



"Plus ça change plus c'est la même chose"*

*(THE MORE IT CHANGES, THE MORE IT IS THE SAME THING)

Over 95% of Sprague capacitors being produced today are different from those of pre-war days —and a lot of hard, painstaking and fast work has gone into making the necessary changes to meet wartime conditions. The primary insulation, the basic dielectric, the fundamental processes—these did not spring full fledged over night, but are "the long result of time." These processes produced good condensers before the war, are producing good condensers now to meet war specifications—and will produce good post-war condensers. Specifications change, the condensers change to meet them, but always Sprague condensers are good condensers. 'Plus ça change——' "

SPRAGUE SPECIALTIES COMPANY, NORTH ADAMS, MASS.

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Just as we do our best to make Sprague a good place from which to buy, so do we aim to make it a good place to which to sell. We are always open to suggestions, new ideas, and all the other helps that suppliers are often so well equipped to give. Although we buy carefully—just as we manufacture carefully—we aim to back this buying with the same courtesy, consideration, and loyalty we ourselves like to receive.

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look ahead

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EVEN with the rapid advancement of science, spurred by war demands, we have seen only a glimpse of what lies beyond the uncharted horizons.

The contributions which Sperti has made in the field of electronics, irradiation and fluorescent lighting (as well as biodynes with all they imply in the field of medicine) are but a promise of significant *new* developments to come.

For beyond Sperti are laboratories devoted to pure research . . . staffed by scientists whose sole purpose is to unselfishly roll back the horizons of human knowledge for the betterment of mankind.

Sperti, Inc. exists to make their mature discoveries available in applicable form.

Even now, though Sperti is almost wholly engaged in war work, there may be a discovery which has a place in your postwar product planning.

It will pay you to keep Sperti in mind—as you turn *your* mind toward tomorrow.

Sperti INCORPORATED

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hance the need for better radio and the growth of the industry.

Functional Approach

(*Continued from page* 84)

semble a gramaphone, a chest of drawers, or imitate an imitation of antique furniture.

Messrs. Hepplewhite, Adams, and others, were limited by the methods of their day and were masters in their time. Today we have plywoods which may be formed by machine, plastics, and a myriad of other mechanically-formed materials. Today we have designers as accomplished in these materials as the old artisans were in theirs.

Controls should not only be recognized but also dramatized. The pleasing effects of combined light and color used with plastics, glass, and metals have unlimited possibilities. Radical changes are not desirable but a more functional approach, not too much influenced by the past, will be healthful for the industry.

PACKAGED MARINE RADIO

(*Continued from page* 89)

cycles for filament power. The motor generator used with battery power supply is identical except that it is of lower power.

Two receivers

The main receiver is a TRF design with a single stage of radio frequency amplification, followed by a regenerative detector, and two stages of audio frequency amplification. Plate and filament power for the receiver are obtained from batteries so that receiver operation is unaffected by failure of the ship's main power supply. Tuning range of the receiver is from 15 to 650 kc in four steps—15-41 kc, 37-105 kc, 95-260 kc and 240-650 kc.

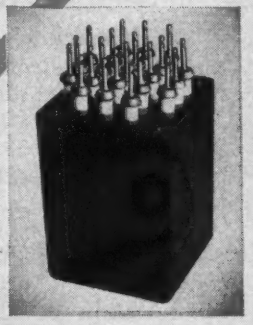
Auto alarm receiver

A second receiver associated with the auto alarm has the requirement that it must function equally well with very strong as well as very weak signals and must accept a weak alarm signal in the presence of strong interference. The reason for these requirements is that the auto alarm receiver must function to operate the standard Mackay Radio Auto Alarm. This alarm is a selective device which will respond only to the international alarm signal. When actuated by the proper auto alarm signal, the auto alarm selector causes bells to ring on the bridge, in the radio operator's quarters and radio room,

When will war production End?

Excerpt from "A Special Report on America's Industrial Future" by The Research Institute of America.

"At the end of the twelve-month period (July 1944), large areas of slowing down and actual cessation in war manufacture will be appearing. This will be a critical period for many companies . . . . IT IS THE PERIOD TOWARD WHICH EXECUTIVE THINKING AND PLANNING SHOULD NOW BE DIRECTED"



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Other products manufactured include:

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● Of this you can be sure: Many business and industrial organizations are losing no time in preparing for a head-start in the competitive postwar market. They are planning and designing new ways to make better products, faster and cheaper . . . through the use of Electronics.

For assistance in *your* planning, General Electronics Industries offers the research engineering skill and specialized experience that have met the exacting tests of war with great achievements in the fields of *Electronics, Hydraulics* and *Electromechanics.* And further, General Electronics Industries has the facilities, equipment and personnel to meet your requirements with speed and efficiency.

Write to Engineering Department, General Electronics Industries, 342 West Putnam Avenue, Greenwich, Connecticut.

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UNIVERSAL microphones really get around. They actually go places and do things. Built sturdy and rugged, they withstand climatic changes and operate equally as well in extreme hot and cold climates. They represent the latest in scientific achievement and engineering design. Complete microphones, together with jacks, cords, plugs, switches, and other integral parts are made at the new UNIVERSAL plants in Inglewood, California. Today, of course, their production is devoted solely to military items for prime and subcontractors, but, when tomorrow comes, and with it a new standard of living in which voice communication via radio and electronics will play an extremely important part these same instruments, and many new models as well, will once more be available through the usual radio trade channels to a public made even more voice communications conscious than in pre-war days.

Available from stock, 1700U series microphone. Single button carbon type, push-to-talk switch, etc. For trainers, inter-communication and general transmitter service.

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as well as notifying deck officers on duty at the same time.

The international alarm signal consists of twelve four-second dashes spaced one second between dashes and is sent on the international distress frequency of 500 kc. The complete system consists of receiving and selecting apparatus located in the radio room and in the radio operator's cabin. The selector of the alarm system consists of three motor timing elements and a bank of counting relays. Timing elements are cams which operate contacts at a certain angular rotation. The arrangement is such that the equipment will operate the alarm bells and lights only upon receipt of the international alarm signal. In other words, any four consecutive dashes of the twelve transmitted must be received and neither the length of the dashes nor of the interval between them may vary by more than one-half second. Thus the equipment effectively discriminates against all signals except the one for which it is set.

Emergency receiver

The emergency receiver is a simple crystal detector intended for use only in case all other available receivers fail. It has a frequency range of from 350 to 550 kc with both antenna and closed circuit tuning.

The remainder of the equipment contained in the transmitter unit consists of the necessary controls for selection of alternate battery units for filament power, charging, etc., as well as emergency dry-cell B batteries. This new marine radio installation was designed and constructed by Federal Telephone & Radio Corp., manufacturing associate of the International Telephone & Telegraph Corp.

HOW UTILITIES USE RADIO

(*Continued from page* 81)

transmitter, receiver, selective call, and power supplies. About one-third of the mobile transmitters are of 35-watt output, and the remainder are 25-watt. They are arranged for two-frequency operation, but only a single frequency is used at present, to simplify the servicing of equipment. Vertical quarter-wave antennas are mounted on the sides of the trucks.

Eight remote receivers for the comparatively small area served may seem a large number, but experience has shown that this relatively large number has been of

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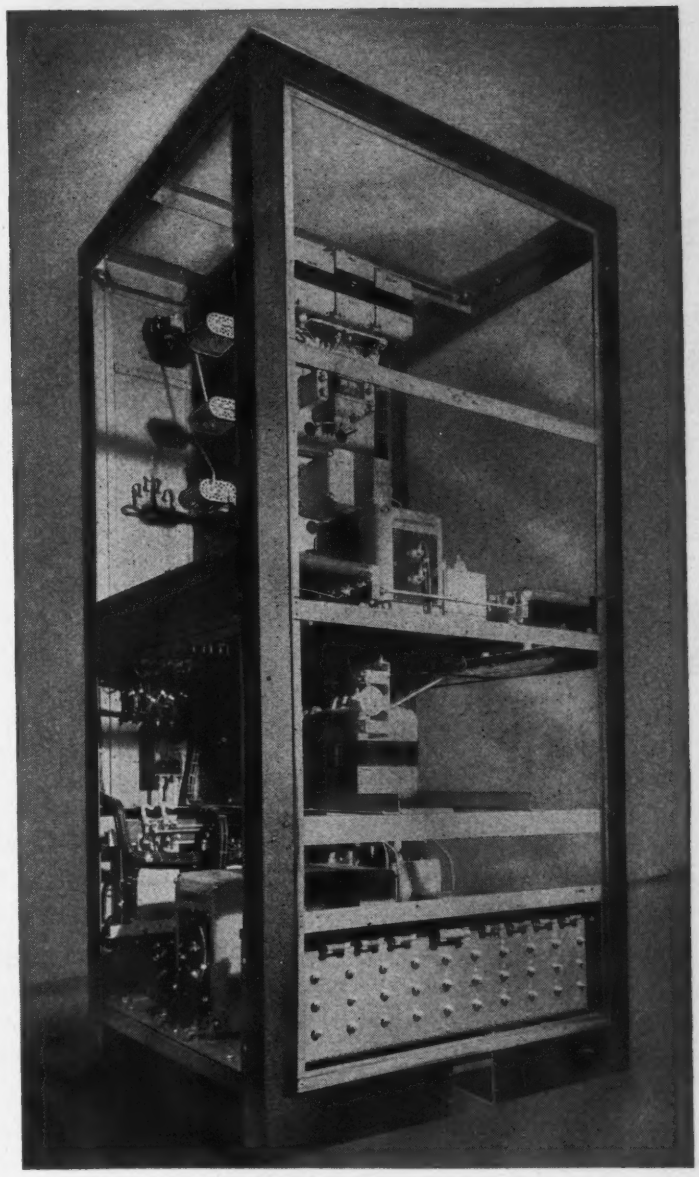

FOR wartime production or postwar planning... in the application of existing devices or the development of new designs... we are ready to help you harness the miracle of electronics to your specific needs. We have the background: 65 years of constant cooperation with the communications industry in all its phases. We have the facilities: military and government agencies may tell you some of the story. And we are neither too big to bother with small problems . . . nor too small to succeed with big ones. Can we get together?

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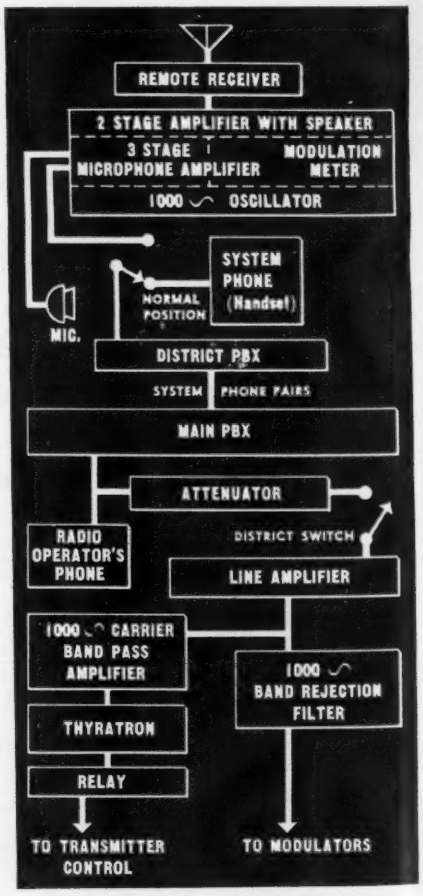
RECEIVERS ★ AUTOMATIC TELEGRAPH EQUIPMENT

considerable advantage because of the great number of diathermy machines which apparently exist in this territory. Other forms of interference also contribute to putting one or more of the receivers out of commission, but it is usually possible to select one or more receivers which are relatively quiet.

Receiver selection

The output of these receivers is fed by means of our private telephone lines to the dispatching point. Here they are fed through an eight-channel amplifier and then through a common amplifier and speaker. Output meters in each channel indicate the relative strength of the incoming signal and show which receivers to select. Switches and pilot lights are installed also in each channel at the control console under their respective output meters. With these switches in the neutral position all channels are feeding a common speaker. When any one or more of the switches is pushed to the down position a red pilot lights and indicates that the particular chan-

Remote transmitter control



Block diagram showing method used by Detroit Edison in controlling transmitter over regular telephone circuits. Tone remains on the line all the time the transmitter is in use but filter attenuation results in its reduction to the point where it is barely audible

"Tablecloth" *Communications*

We're back at our pencil doodlin' again... and—dramatized above is an idea of how HARVEY-WELLS communications equipment "steps in" to a particular industrial problem.

In an industrial plant, with a problem similar to that illustrated above. where wiring is impractical, HARVEY-WELLS equipment fits the picture perfectly, because the crane operator receives direct, instantaneous instructions from the floor man regardless of noise or confusion.

No doubt you're thinking of post-war operations in your own business, and communications belong in your plans. Of course, the actual instruments aren't available today, BUT the "know-how" is; and because of what we're doing today for our government, YOUR equipment will be BETTER in design, lighter in weight and more compact through skilled engineering.

Tell us about your industry and what your communications problems are; and we'll do some practical "pencil doodlin'" for you.

HARVEY-WELLS *Communications inc.*

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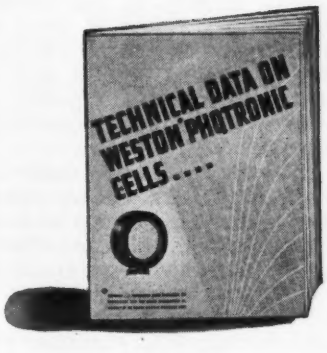
Photronic Cells now being made for war purposes only, hold many new possibilities for design engineers searching for better methods or new products for post-war markets.

The improved Type 3 photo-cell has a marked increase in sensitivity and can be produced in various outputs and various linearity factors, to meet specific circuit requirements. They can be matched in spectral sensitivity, too; to give practically the same spectral response curve throughout the color spectrum. And since the fatigue factor has been materially reduced, their response is more uniform, and far more rapid.

The development of the Type 3 is the result of continued research and experience in the processing of photo-cells dating back to 1930 . . . the year in which WESTON introduced the first American-made commercial cell of the barrier-layer type.

Type 3 Photronic Cells can be supplied in various styles and cases, as well as unmounted in a variety of shapes and sizes. Complete technical data, in booklet form, available to design engineers on request. Weston Electrical Instrument Corporation, 666 Frelinghuysen Avenue, Newark, New Jersey.



*PHOTRONIC—*A registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corp.*

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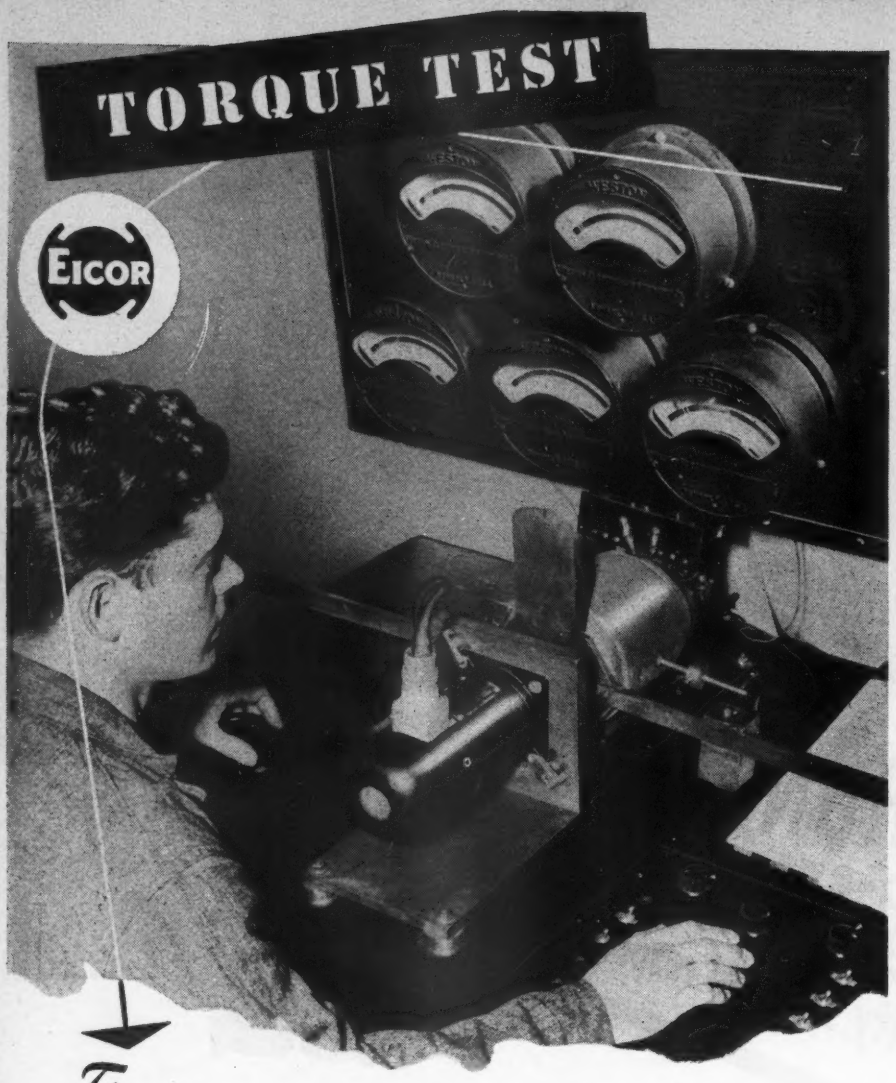
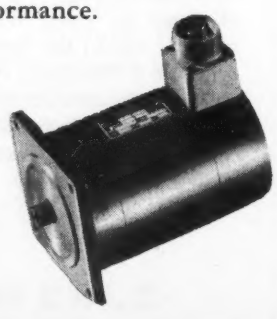


To make accurate final torque tests on DC motors, our engineers designed special dynamometers for production testing. This test equipment gives output readings far more quickly and accurately than obtainable by ordinary means. It enables us to check the motors at normal or over-voltage, at normal load or overload, and exactly at the specified speeds. Torque and efficiency are then quickly calculated and, together with other operating data, noted on test sheets. During the course of this test, separate checks are made on the armature and field circuits, and on the commutation. And necessary adjustments can readily be made to achieve perfect performance.

This dynamometer is one example of numerous devices designed and built in our laboratories to help us supply more and more EICOR quality Motors and Dynamotors to our customers. Specialization in our chosen work makes possible such developments; it will also be reflected in EICOR products of Tomorrow.



EICOR INC. 1501 W. Congress St., Chicago, U.S.A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
Export: Ad Auriema, 89 Broad St., New York, U. S. A. Cable: Auriema, New York

nels involved are cut out of the circuit. On the other hand, pushing a switch to the up position lights a green pilot and shows that that receiver only is the circuit.

This FM two-way equipment has been in operation for a little more than two years. It was preceded by an AM system, which was in existence for several years, consisting of a 150-watt main station transmitter, several mobile transmitters, and about forty-five receivers. It was found that the AM system was inadequate for the coverage because of the very high noise level in this area. The low power was the principal factor, although our experience has been that FM of comparable power is quieter, particularly between transmissions, or during standby periods.

With the AM system the noise was often so great that the volume control of the receiver was turned down to reduce the annoyance, and as a result, signals were missed. In order to avoid this particular difficulty in our FM system the gain controls have been so devised that the minimum position of the controls still permits reasonable speaker volume.

While the system is of great value in a storm or under exceptional conditions its greatest value comes from the day to day use in meeting emergencies.

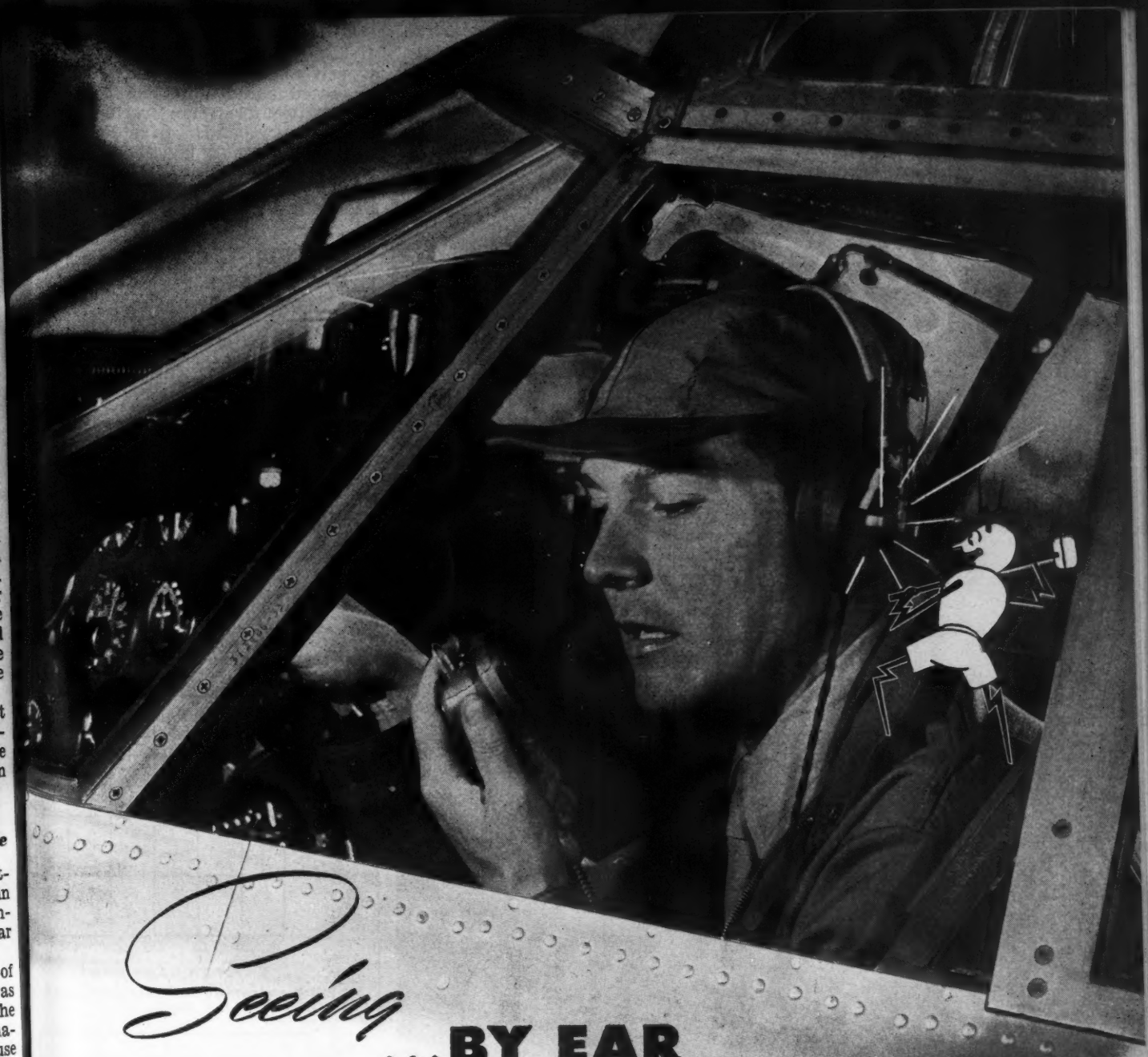
Radio interference

Our company began investigating sources of radio interference in 1922 with the number of cases investigated rising rapidly each year to a maximum in 1929 or 1930.

About that time our method of handling radio interference was radically changed. Instead of the radio interference calls being a liability and expense we began to use our radio equipment as a tool for use in locating trouble and incipient trouble in our lines and equipment. Radio is used as an auxiliary in the patrol of our lines and equipment, and it was found that incipient trouble usually could be detected before serious fault occurred.

In order to use the radio in this manner it is necessary that the lines be kept quite free of interference in general so that when any interference does appear it can be traced to its source and the trouble eliminated. The result of this practice has been that customer reports of interference have been reduced to a very small number and these are usually the result of interference from customers' equipment. In general, the company does not attempt to eliminate interference caused by such appliances although we will furnish advice on request.

The principal tools used in locating interference are multi-band re-

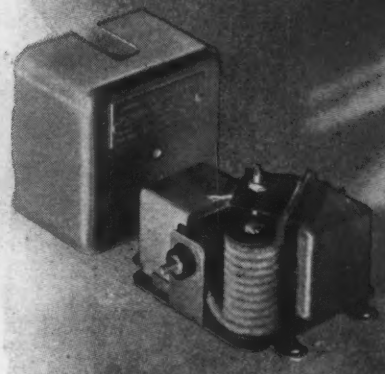


Seeing ...BY EAR

A fighting man must fly blind sometimes, but deaf never. In long range bombers . . . in scrappy pursuit planes . . . whatever the visibility, vital communication channels must be kept clear. Unless the proper suppression filter system is installed, noisy radio interference acts like a pack of demons . . . sabotages communications upon which the safety of men and their military missions depend.

Solar Elim-O-Stats are Communications' Life-savers. They are compact filters which protect against local static, absorbing it *right where it starts*—at generators, motors, contacts, and other sources. Solar Capacitors are reliable components used by practically all leading manufacturers of military radio equipment. From command car to jeep or tank . . . from ship to ship or plane . . . between planes—wherever radio is vital—Solar Capacitors and Elim-O-Stats help keep channels clear, so fighting men can hear.

If you have a problem concerning capacitors or radio noise suppression, call on Solar Manufacturing Corporation, 285 Madison Ave., New York 17, N. Y.



Solar SOLAR—ELIM-O-STATS—

CAPACITORS AND RADIO NOISE-SUPPRESSION FILTERS

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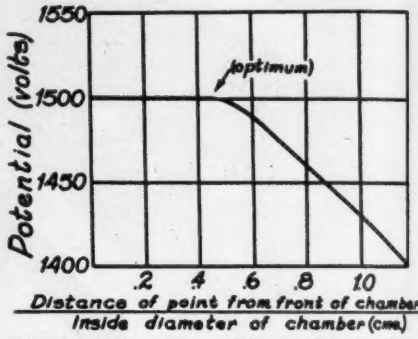
ceivers, power amplifiers, loop-operated audio amplifiers, and some portable receivers covering various frequency bands. In addition, special equipment is used on certain types of interference which are usually difficult to locate, or about which a study is being made.

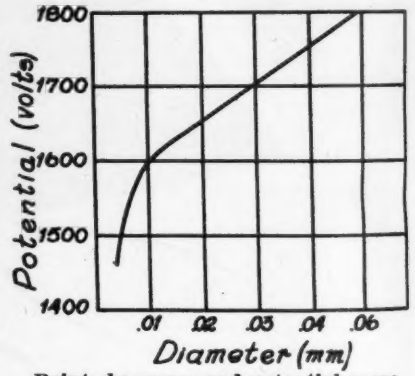
COUNTING RADIOACTIVE PARTICLES

(*Continued from page* 99)

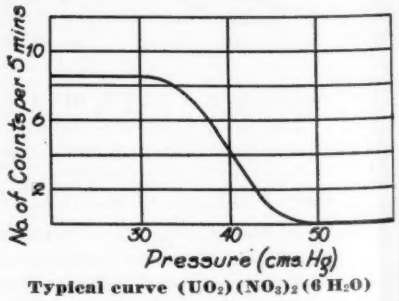
sas oil stone is then used until, with a 20x Hastings Triplett glass, the



Relation of needle position and potential



Point sharpness and potential curve



Typical curve $(UO_2)(NO_3)_2(6\,H_2O)$

point appears very fine and sharp. Polishing with a pinch of tin oxide (Diamontine) on the top of a hard, varnished wood surface follows.

Such a needle will take approximately 1,800 volts before sparking and gives disturbances frequently. Cleansing in alcohol and heating to blueness in a bunsen flame coupled with a rest period normally eliminate this difficulty and tend to decrease the voltage necessary for operation.

Some working characteristics of

RADIOTELEPHONE EQUIPMENT

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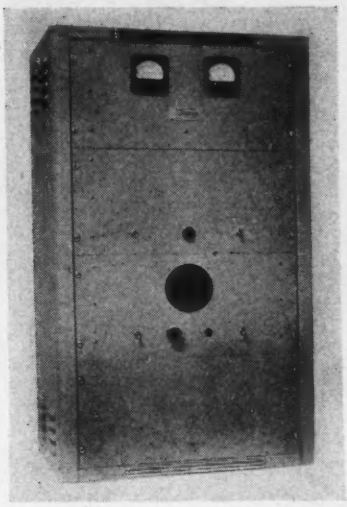
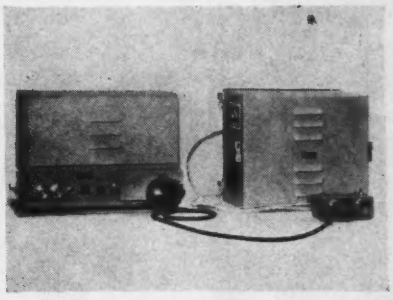
Complete 22 Watt High Frequency Mobile Installation

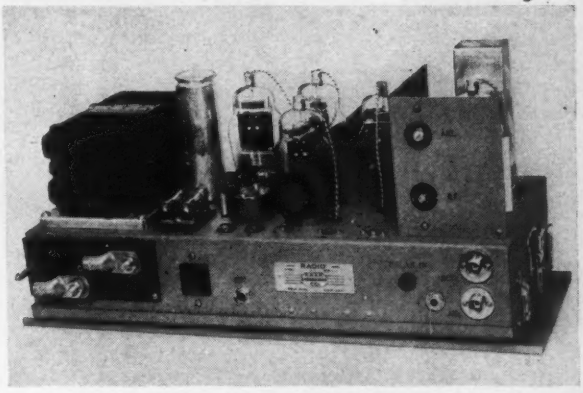




Type 11X Receiver and PTL-10X Transmitter for Mobile Applications.

★ ★ ★ ★ ★ ★ Complete 50 Watt Central Station Installation. ★ ★ ★ ★ ★ ★

Type PRS-9X, 30-40 MC Mobile Receiver with Dust Cover Removed.



Type PTS-22X, 30-40 MC Mobile Transmitter with Dust Cover Removed.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

PARTIAL LIST OF TYPICAL PRODUCTION MODELS

SERIES 17	10 Watt Multi-Channel Transmitter, Receiver and Power Supply in 8¾" x 15" x 11" Cabinet. 6 and 12 Volt DC and 117 Volt AC Models available.
SERIES 26	20 Watt Multi-Channel Transmitter and Receiver available for operation from 6, 12, 32 and 110 Volts DC or 117 Volts AC.
SERIES 56	50 Watt Multi-Channel Transmitter and Receiver available for operation from 12, 32 and 110 Volts DC or 117 Volts AC.
SERIES 6	Includes Tunable and Multi-Channel Fixed Tuned Receivers for Mobile, Marine or Central Station application.
TYPE 11A	Single Frequency Crystal Controlled Station Receiver for frequency ranges up to 8,000 KC.
TYPE 11X	Crystal Controlled Mobile Receiver, for frequency ranges up to 8,000 KC.
TYPE PTL-10X	Instant Heating 10 Watt Mobile Transmitter, for frequency ranges up to 8,000 KC.
TYPE PTL-22X	Instant Heating 22 Watt Mobile Transmitter for frequency ranges up to 8,000 KC.
TYPE PTS-22X	Instant Heating 22 Watt Mobile Transmitter, range 30-40 MC.
TYPE PR-9X	Crystal Controlled Mobile Receiver, range 30-40 MC.
TYPE PRS-9A	Crystal Controlled Station Receiver, range 30-40 MC.

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for the COMMUNICATIONS ENGINEER

Quantitative measurements of the performance of electrical circuits depend upon instruments for the measurement of voltage, current and power. Limited-range, single-frequency instruments are adequate at power frequencies, but measurements at communication frequencies require specialized types covering wide ranges of frequency and voltage.

Since 1915, the General Radio Company has been building these special-purpose meters for the communications industry. The present line includes both copper-oxide and vacuum-tube types covering a frequency range from d-c to ultra-high radio frequencies, and a voltage range from 50 millivolts to 300 volts.

In war time as well as in peace, the leading communication laboratories are equipped with General Radio instruments, backed by 28 years of experience in designing and building high-quality apparatus.

Because all our facilities are devoted to war projects, these meters are at present available only for war work.

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Cambridge 39, Massachusetts
NEW YORK 6 LOS ANGELES 38

the needle electrode with respect to pressure, chamber position and sharpness are shown in the first three curves. The final plot in this series depicts typical results obtained with the apparatus as a whole.

Key to Apparatus
(Chamber Unit)

T—Variable, high voltage source (400-2500 v.d.c.). I.C.—Brass ionization chamber (4 cm long, 2 cm inside diameter, 0.300 cm and 0.139 cm aperture diameters) with Bakelite stopper, which carries needle. S—Radiation source. A—10 megohm grid leak. B—1 megohm grid leak. C—.001 MFD condenser. E—Positive side of high potential and apparatus shielding are both grounded. 1—Detector-amplifier triode (Type 6J5).

(Amplifier Unit)

2 and 3—6J5 tubes (as in chamber unit). Note: Headphones or a loudspeaker may be connected across the output for demonstration and checking purposes.

(Thyratron Unit)

R_1—910 ohm resistance. R_2—1790 ohm resistance. R_3—630 ohm resistance. A—Weston ammeters. C—20 MFD condenser. T—Filament transformer. E.C.—Type 60s Cenco impulse counter. 4 and 5—FG-17 (G.E.) Thyratron tubes.

COLLOIDAL GRAPHITE FILMS

(*Continued from page* 98)

beneficial in that they exhibit little affinity for the sputtered particles from activated filaments. By preventing the permanent "alloying" of these alkaline earth oxides with metallic tube parts, "back" emission is eliminated.

It should be remembered that graphite shows little photoelectric effect. It is at the same time remarkably stable under electron bombardment, making it an excellent coating material for metals and glass which are subjected to the impact of primary particles.

Electrostatic shield

Coatings produced with aqueous graphite dispersions may be applied to the exterior of vacuum tubes that require electrostatic shielding. A typical example is the FP-54 Pliotron which acquires surface charges simply by handling. These tend to leak off through the control grid circuit, appreciably increasing the grid current. The manufacturer of this tube recommends that "Aquadag" be applied to the bulb as an external coating to within an inch of the control grid connection. This improvised shield is then connected to a source of potential equal to that of the grid, thus bringing about the dissipation of any charges which may have accumulated on the bulb.

A commercial application embodying fairly large surface areas is represented by its use in the shielding of electronic musical instru-

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The ingenuity of the N-Y-T Sample Department is represented in practically every point above and below the four corners of the earth.

Specializing exclusively in the design and development of audio and power transformers, chokes and filters for highly critical requirements, these custom-built units experience every conceivable electrical and mechanical operating condition.

Abrupt and extreme temperature fluctuations, moisture, acid fumes, concussion, humidity, etc.—yet maximum performance is assured at all times. Too, substantial savings in weight, area and mounting space attest to the resourcefulness of N-Y-T engineering.

The Sample Department, now devoted 100% to problems pertaining to Army, Navy and Air Corps applications, will be available to you later, for peacetime needs.

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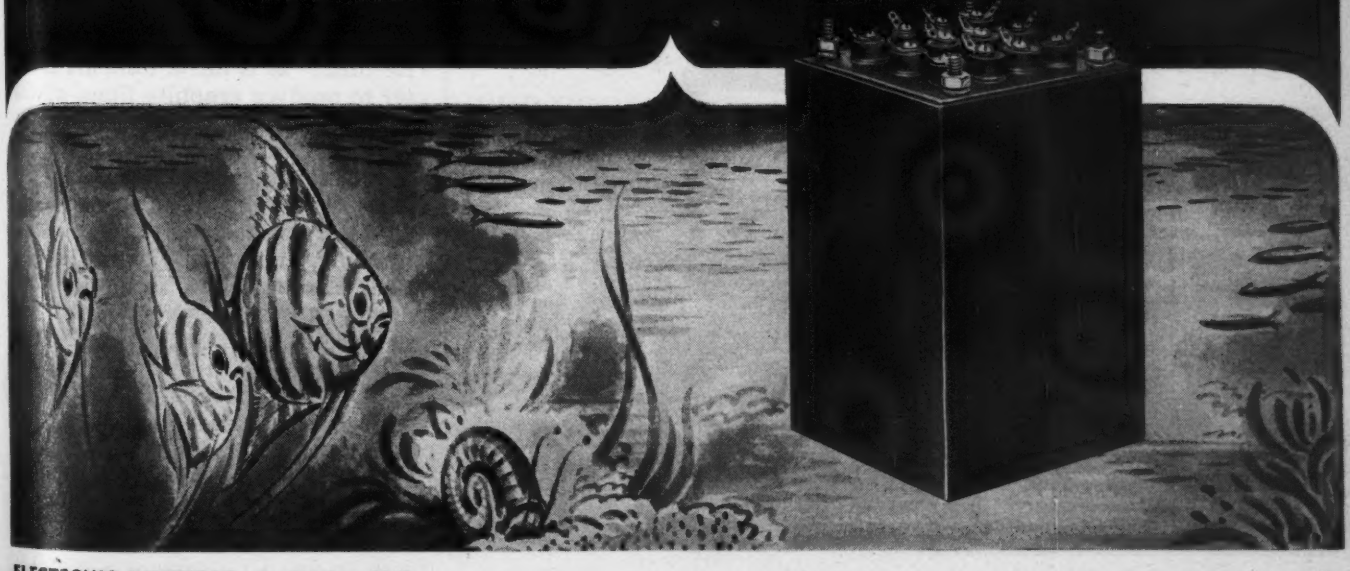
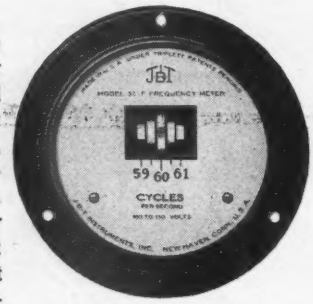


They're Versatile!

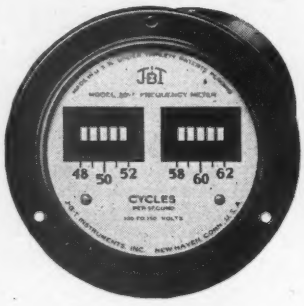
Here are a few of the many models in the J-B-T line of Vibrating Reed Frequency Meters for measuring frequency of AC or interrupted DC. Vibrating reed indicates actual frequency or r.p.m.

● versatile because they are being used on portable engine-generator sets in the field, where mud and grit and vibration are the rule, not the exception — in laboratories, where accuracy is the prime consideration—in telephone, television and radio service, and in the many types of electronic equipment where power consumption must be low—and in stationary applications where continuous operation demands durability.



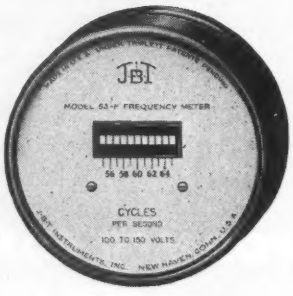
Model 31-F, 5 reed, half cycle increment.

● the list of uses grows daily. Many are wartime uses which cannot be specifically mentioned. It can be said, however, that thousands of J-B-T Vibrating Reed Frequency Meters are protecting vital equipment where successful operation depends on constant or known frequency.



Model 30-F, double window, for ease in reading frequency in either range.

● these instruments are not affected by wave form, normal temperature change or external magnetic fields. Accurate to ± 0.3% or ± 0.2% depending on the model, and available for frequencies from 15 cycles to 420 cycles, for various voltages, and with several reed groupings and case sizes, full or half-cycle increment, sharp or broad response.

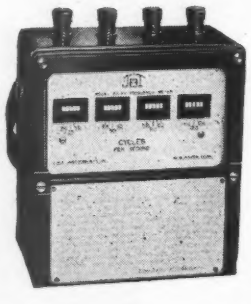


Model 53-F, 5 inch, 9 reed, for front-of-panel mounting.

Better requisition several ranges for your own use—they're so versatile, you'll wonder how you ever got along without them.

For details on the complete line of J-B-T Frequency Meters, send for Bulletin VF-43—and if interested in 400 cycle meters, also for VF-43-1A.

J-B-T



Model 60-FP, portable, covering four ranges.

(Manufactured under Triplett Patents and/or Patents Pending)

10-JBT-7

J-B-T INSTRUMENTS, INC.

433 CHAPEL STREET • NEW HAVEN 8, CONNECTICUT

ments, which are especially sensitive to stray alternating electrostatic fields. By painting the inside cabinet surfaces of an electric piano with an aqueous suspension of colloidal graphite and grounding the coating so produced, hum-free performance is obtained.

In copper oxide rectifiers it is necessary that the rough crystalline cuprous oxide discs or plates, upon which rectification of the alternating current depends, make intimate contact with adjacent disks or plates. When this type of rectifier was first designed, an attempt was made to achieve positive contact between the elements by inserting soft metal washers. Upon mounting the parts on a threaded rod and exerting pressure with a nut, it was hoped that the flow of soft alloy would produce the desired effect. The deformation of the metal was imperceptible, however, resulting in the adoption of colloidal graphite as the contact agent. When the oxide layers are sprayed with dilute "Aquadag," the graphite fills in the cavities between the crystals to yield a smooth surface affording a large contact area.

Highly concentrated aqueous dispersions of graphite, having the consistency of a paste, are commercially available. This material makes a useful conducting cement. It has long found practical application in the manufacture of therapeutical and other carbon filament lamps where it serves as a clamping paste for attaching the filament to the lead-in wires. It may also be used for making connections between graphite coatings and ground wires, cat whiskers and the like, or for any similar purpose wherein positive contact under difficult conditions is required.

In most of the applications described so far, use was made of the conducting properties of graphite films. It is not a difficult matter to produce graphite films which function as resistances.

If colloidal graphite is applied to non-conducting media like paper, glass, ceramic or resinous materials by such procedures as spraying, painting, dipping or electro-deposition, it is possible to form elements having a comparatively broad resistance range. Dispersions of colloidal graphite in phenolformaldehyde varnish have been successfully used in the production of resistors having extremely high ohmic values. Coatings rich in graphite which have undergone polishing or pressure have a low resistance,

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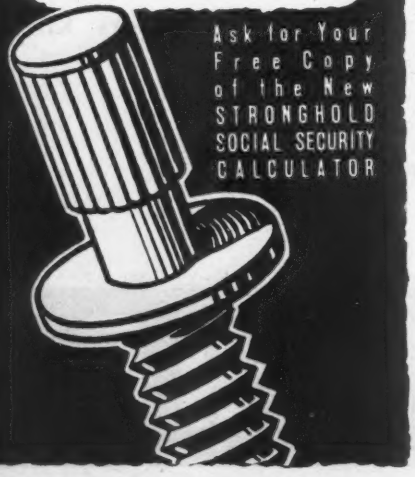

while thin films, or layers comprised of intimate mixtures of graphite and a non-conductor, obviously exhibit high resistance properties.

Light-sensitive cells

Patents have been granted covering the use of "Aquadag" films in phototubes employing selenium and tellurium. The advantage of graphite over other electrode materials in this application lies in its inability to combine with selenium to form a selenide. Since the electrical conductivity of selenides is greater than that of the element itself and inasmuch as the selenide formation is usually progressive, the sensitivity of a unit containing the graphite film does not decrease with age.

Graphite exhibits a peculiar affinity for cesium, which property is also utilized in the manufacture of photoelectric cells and half-wave rectifiers.

When the latter type of tube is placed in operation the heat from the filament liberates the alkali, converting it into vapor in the region between the electrodes. When the tube cools, the cesium is adsorbed by the graphite. It is stated that even if alkali metal has become affixed to the glass envelope, the metal gradually vaporizes at room temperature and is ultimately taken up by the graphite layer.

In the manufacture of photoelectric cells the inclusion of a metallic plate previously treated with "Aquadag" makes unnecessary the usual practice of baking the cell at high temperatures to remove excess alkali metal. The graphite-treated member accomplishes this by adsorption.

Electrical applications

When colloidal graphite in the form of "Aquadag" is painted on the insulating covering of armature conductors of high voltage alternators, corona difficulties are eliminated. Similar aqueous paint when used on driving belts serves to dissipate any charges which may be generated by the friction between air and the belting, the flexing of the belting and its slippage on the pulley. Colloidal graphite is effective for blackening the receivers of thermopiles, particularly those designed for use with long infra-red rays.

Just as graphite films may be used as electrodes in vacuum devices, so may they be employed for

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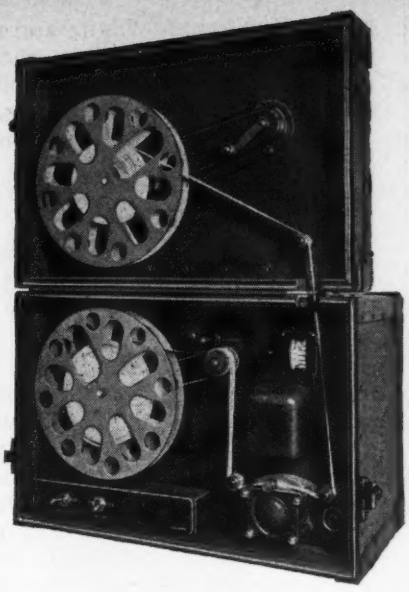

Men in our Armed Forces quickly learn how to receive international code on this Portable Keyer made by Waters Conley. It takes an inked record from paper tape and converts it, by the magic of electronics, into audible code signals.

This companion to the Waters Conley Recorder is another of the war-vital products that take all our time these busy days. But much of the knowledge and experience we are gaining in wartime will help to enrich civilian life when peace comes again... and will open profitable new markets for you.

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Split Seconds Count

★

U. S. Army Signal Corps Photo. Back-carried Walkie-Talkie two-way voice radio

★

● There can be no time lost where instant reports of enemy actions must be relayed,—for split seconds lost may mean unnecessary sacrifice of men and equipment.

For the modern Walkie-Talkies of the U. S. Army Signal Corps, nothing short of complete reliability is required of the transformers used, and the tens of thousands of Jefferson Electric Transformers have proven their reliability, long useful life, and freedom from unnecessary servicing in the field of combat where time and manpower must be saved . . . JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. Canadian Factory: 60-64 Osler Ave., W. Toronto, Ont.

JEFFERSON ELECTRIC

insulation tests on ebonite and soft rubber. "Aquadag" when chosen for this purpose is easily applied, dries with definite boundaries, is chemically inert, makes intimate contact and can, if desired, be retained in place permanently (unlike mercury).

Non-conductors of electricity may be electroplated by being pretreated with colloidal graphite in a suitable carrier.

Colloidal graphite is capable of being electro-deposited (electrophoresis) either alone or in conjunction with an ion in solution. Low friction copper-graphite combinations have been prepared by this method. It might be well to add that one type of resistor is prepared by electrophoretically coating stainless steel plates with graphite from an aqueous suspension. After the coating has been dried, the plate is placed in contact with paper strips which have been impregnated with an uncured phenol condensation product. By applying both heat and pressure, the graphite is quantitatively transferred from the steel plate to the paper strips. Such a strip, when suitable mounted on a non-conducting base, serves as a resistance unit. Variable resistors prepared in this manner find utility as volume controls in broadcast receivers.

Colloidal graphite thus serves many special purposes in the electronic and allied industries. As further research reveals new problems, this versatile material should find ever wider application.

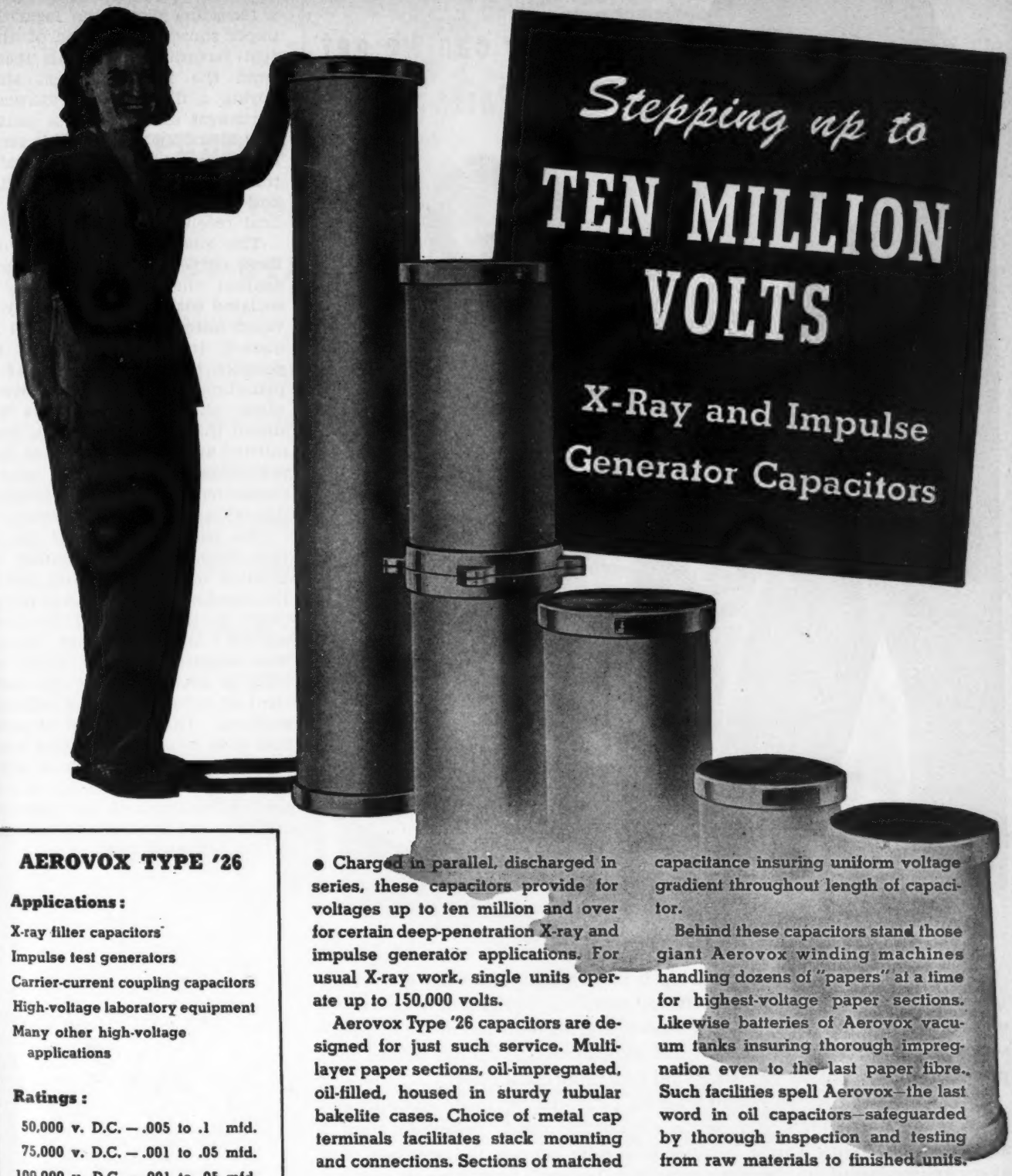
AIRPORT CONTROL WITH UHF

(*Continued from page* 101)

the airplane was in level flight over a fixed point at various headings and constant altitude. Also shown on this figure are the results of recordings made during left and right hand turns with the wings in level position. The pattern obtained in level flight over a fixed point is considered correct for this condition. The other patterns are subject to error due to the unavoidable change in position when flying a circle.

Field patterns

Transmitting vertical field patterns were obtained from recordings made during flights across each station at a constant altitude and with the receiver set on manual volume control. Reproduced is



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High-voltage laboratory equipment
Many other high-voltage applications

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75,000 v. D.C. — .001 to .05 mfd.
100,000 v. D.C. — .001 to .05 mfd.
150,000 v. D.C. — .001 to .03 mfd.

● Charged in parallel, discharged in series, these capacitors provide for voltages up to ten million and over for certain deep-penetration X-ray and impulse generator applications. For usual X-ray work, single units operate up to 150,000 volts.

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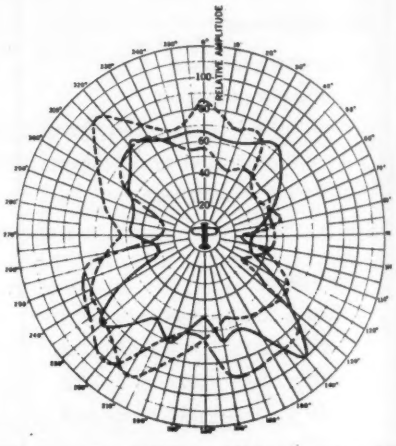
a recording plotted on logarithmic paper showing a portion of an actual recording of signals received from the Floyd Bennett station during a flight in a southwest to northwest direction at a constant altitude of 2,000 feet. This recording represents the resultant of the transmitting vertical field pattern and the airplane's nose-to-tail vertical receiving pattern.

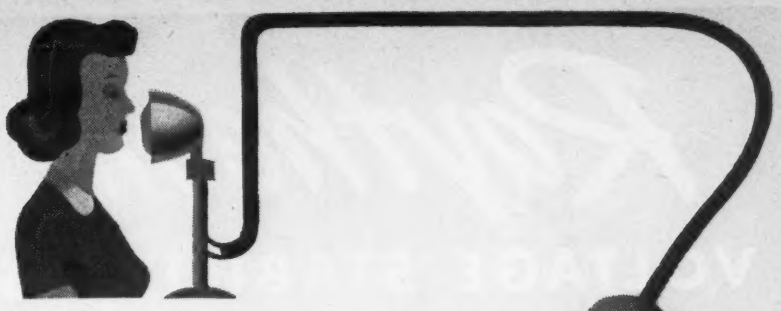
The lobe phenomena shown on these curves are an inherent propagation characteristic usually associated with the use of highly elevated antennas in ultra-high frequency transmission. It is only possible here to give a brief explanation of the theory covering these phenomena. It has been shown that the field from a transmitting antenna at a point in space not beyond line of sight, may be considered as due to the combination of a direct and reflected ray.

The path difference of the two rays determines the number and location of the peaks and nulls in the transmitted field and is proportional to the height of the transmitting antenna above ground. The amplitude of the peaks and nulls is determined by the coefficient of reflection of the reflecting medium. The coefficient of reflection is in general a complex quantity, the value of which is determined by the conductivity and dielectric constant of the reflecting medium, and the angle of incidence of the reflected ray.



Horizontal pattern obtained with airplane in level flight over a fixed point at various headings

For horizontal polarization and the same reflecting medium, the reflection coefficient increases with the decrease in the angle of incidence and approaches a value of unity at grazing incidence. This results in the fact that for a perfect reflecting medium the reflection coefficient can theoretically



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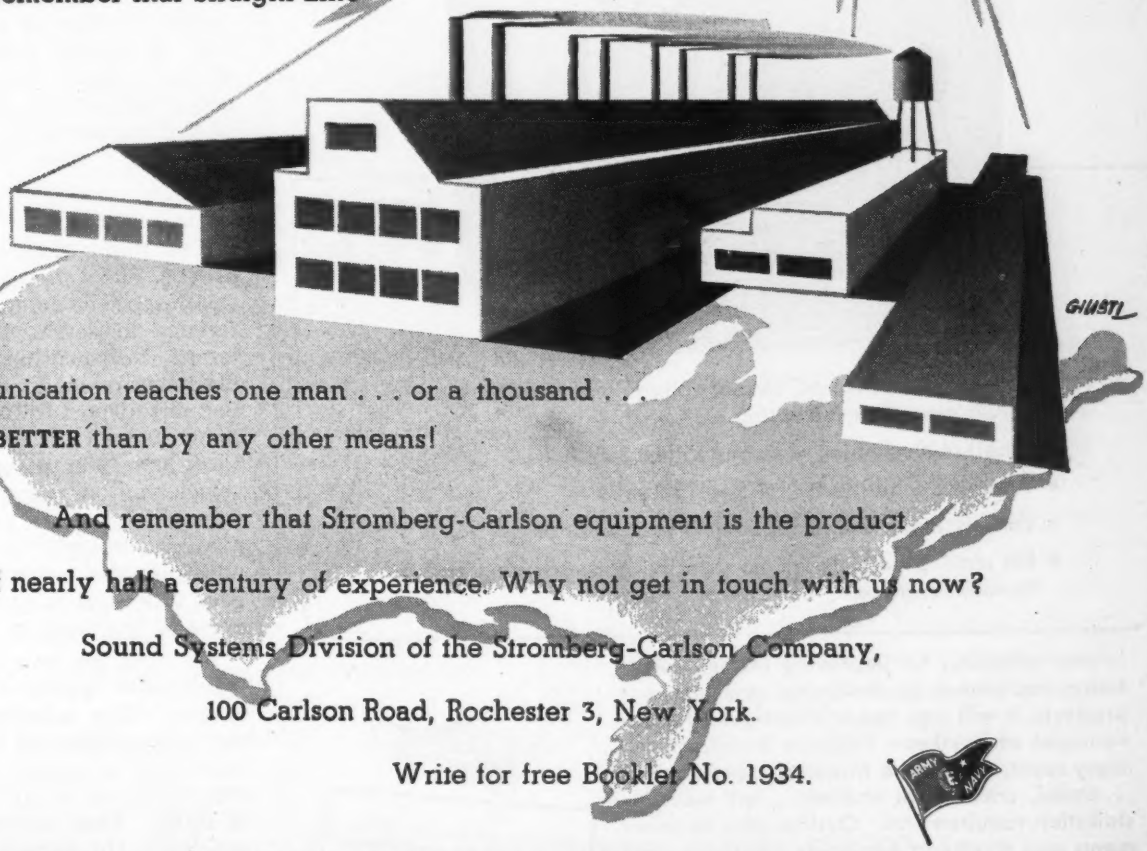

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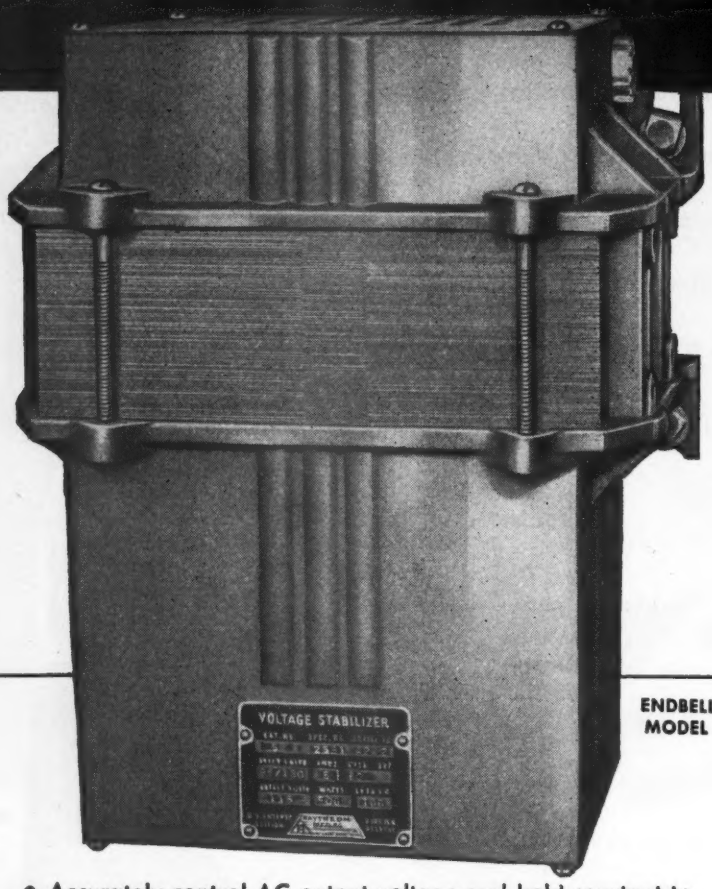

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affect the transmitted field at points in space to the extent that the null points will approach a value of zero and the peak points a value of twice the direct ray.

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BRENTWOOD, L. I.	36 MILES	1000 FEET	EXCELLENT
NEW BRUNSWICK, N. J	32 MILES	1000 FEET	EXCELLENT
TERRYVILLE, L. I.	48 MILES	1000 FEET	FAIR
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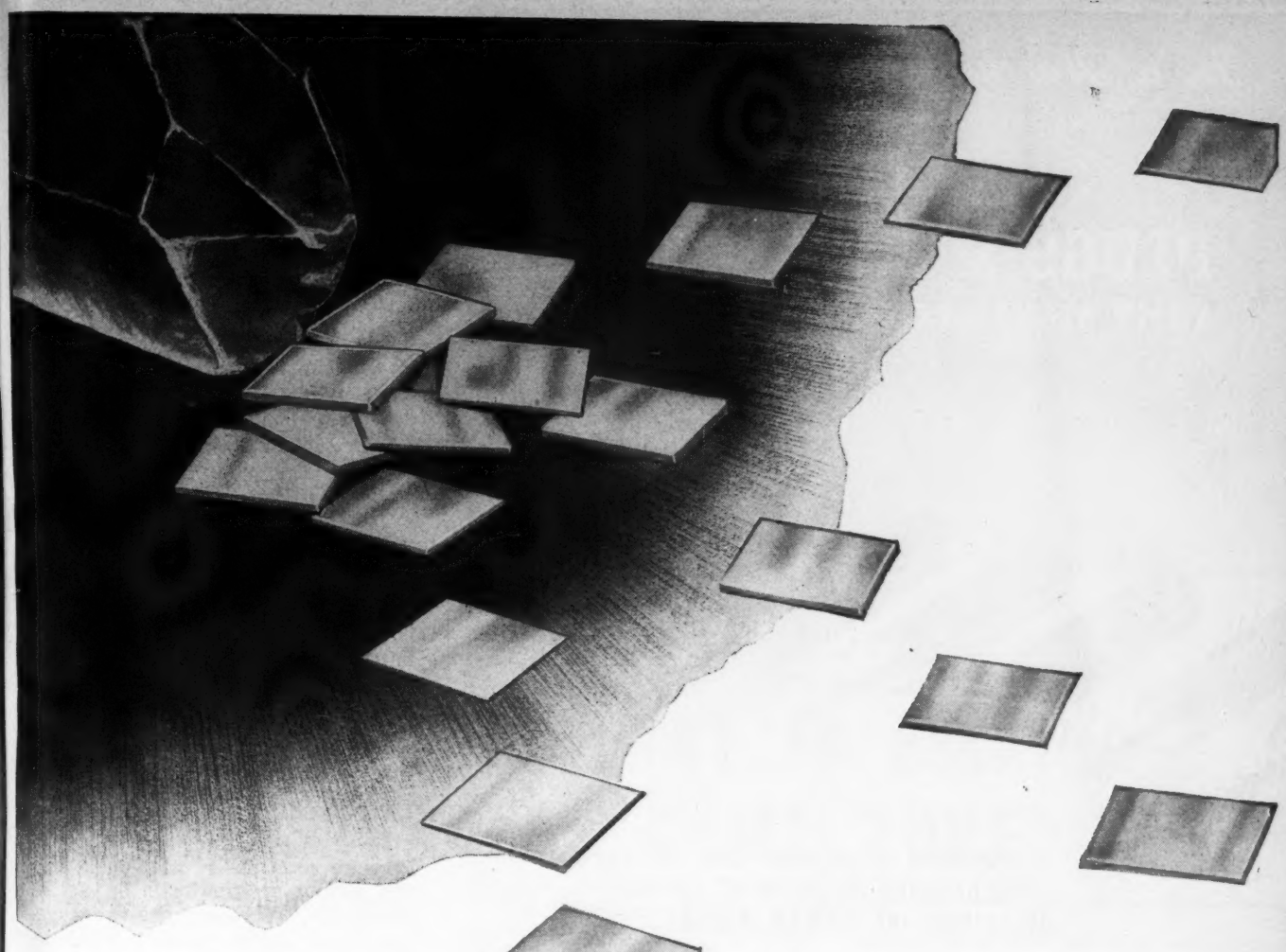
ROCKY POINT, L. I.	54 MILES	1000 FEET	JUST AUDIBLE
NEW BRUNSWICK, N. J	32 MILES	600 FEET	FAIR
NORWALK, CONN	44 MILES	500 FEET	JUST AUDIBLE
LAGUARDIA-130.3 MEGACYCLES			
NEW BRUNSWICK, N. J	37 MILES	1000 FEET	EXCELLENT
NORWALK, CONN.	35 MILES	500 FEET	FAIR
TERRYVILLE, L. I.	44 MILES	1000 FEET	FAIR
ISLIP, L. I	35 MILES	1000 FEET	JUST USABLE
NEW BRUNSWICK, N. J.	37 MILES	600 FEET	JUST USABLE
ROCKY POINT, L. I	50 MILES	1000 FEET	JUST AUDIBLE
PHILADELPHIA-131 42 MEGACYCLES			
OVER FLOYD BENNETT	86 MILES	4500 FEET	FAIR
OVER FLOYD BENNETT	86 MILES	5500 FEET	EXCELLENT

It will be realized that the occurrence of a condition of zero signal would be very undesirable. In the case of this recording of the Floyd Bennett station, a similar recording was made except with the receiver operating on automatic gain control, with the result that there was a maximum decrease in receiver output of approximately 6 db. A similar change in output during speech transmission would not interfere with the intelligibility of the transmission.

Service range

Two flight tests were conducted at the Floyd Bennett station for the purpose of determining the difference in service range for different transmitting powers. The flights were made from the Floyd Bennett airport to Center Moriches, Long Island, at an altitude of 1,000 feet. For these tests, the receiver was operating on automatic volume control and recordings were made alternately of the tone signal from the output of the bandpass filter and the tone signal plus noise to the input to the filter.

The first test was made with the transmitter operating at 100 watts output. The intelligible limit, or the point where the ratio of signal plus noise to signal is two to one, was found to be at a distance of 48 miles. This corresponds nearly exactly to the distance of the theoretical line-of-sight for this flight. The second test was made with the transmitter operating at about 30 watts output. At this power and altitude, the intelligible limit was found to be at a distance of 42 miles.



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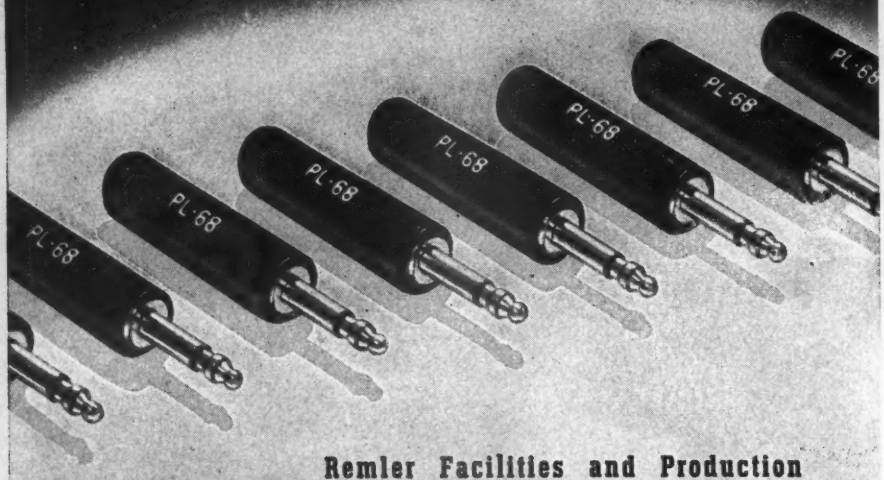

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56	64	104	124	354	61	76	61	76	61	76
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AC MOTOR OPERATION ON AC

(*Continued from page 87*)

trol applications cannot be obtained feasibly by conventional dc drives. The electronic control widens the scope of dc motors by enabling them to operate from an ac line and by overcoming or compensating for their inherent faults. In order to visualize most clearly the operation of the electronic control, it is well to consider it as three individual units: a thyratron-type rectifier to provide dc from the ac power supply; an electronic control circuit which acts on the thyratron rectifier to produce the required functions; an auxiliary magnetic control circuit to provide the proper operating sequences.

Uses rectified power

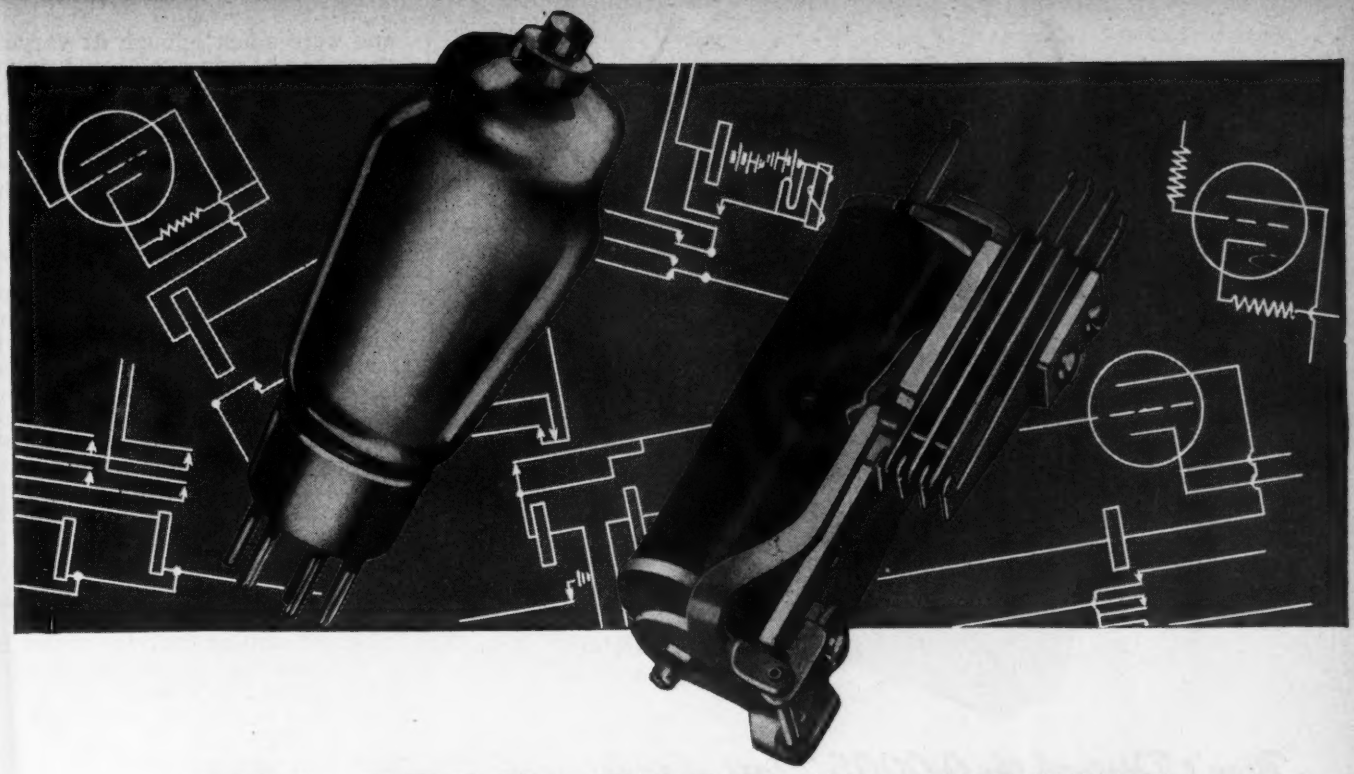
A set of thyratron rectifier tubes is used in the armature circuit, and a pair of thyratron or phanotron rectifier tubes (depending on whether the field is to be variable or fixed) is in the field circuit. The output voltage of the thyratron rectifier is dependent on the phase angle at which the tubes fire.

If the tubes fire at the beginning of a cycle, current will flow through each entire half-cycle and the output voltage will be at its maximum, whereas if the tubes fire late in the cycle, current will flow during a shorter period of time and the output voltage will be at a minimum. This control is accomplished by means of a saturable-reactor phase-shifting bridge.

If there is no dc flowing through the dc (control) winding of the saturable reactor, the tubes will be turned off to give minimum voltage. If the saturable reactor, however, is saturated by the dc flowing through its control winding, the tubes will be turned full on and the output voltage will be at its maximum.

Let us assume that both the armature and the field supplies are to be variable. The armature voltage could be varied by means of a direct current through the saturable reactor SRA and the field voltage could be varied by means of a direct current in saturable reactor SRF. By decreasing the current in SRA, while maintaining full current through SRF, the motor is made to start at reduced armature voltage and with full field, and can then be accelerated by increasing the current flowing through SRA. As the motor accelerates to full armature voltage the field can be weakened by decreasing the current through SRF.

As load is applied to the motor, the armature voltage can be increased to compensate for internal motor resistance drop. In fact, if



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All along the fighting fronts where the tools of war are being used —and in industrial plants where they are being made—electronic science is working miracles to hasten the day of victory.

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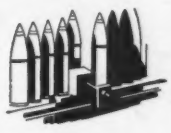

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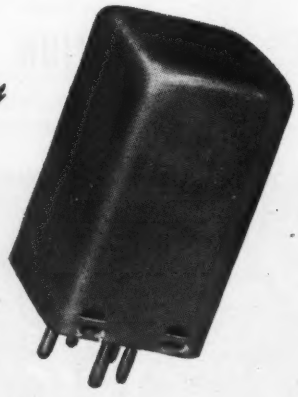

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one were adept enough at varying these two currents, he could duplicate all the Thy-mo-trol features (except reversing which is accomplished magnetically), for that is just what the electronic control circuits accomplish automatically.

Control circuits

A source of dc potential to supply the various requirements of the control circuits is provided through rectifier tube A. Since industrial line voltages are subject to variations, tubes B and G, which are of the constant-potential glow type, are used to insure that the potential across lines 5 and 7 is fixed at 150 volts or 75 volts across each tube.

Armature control

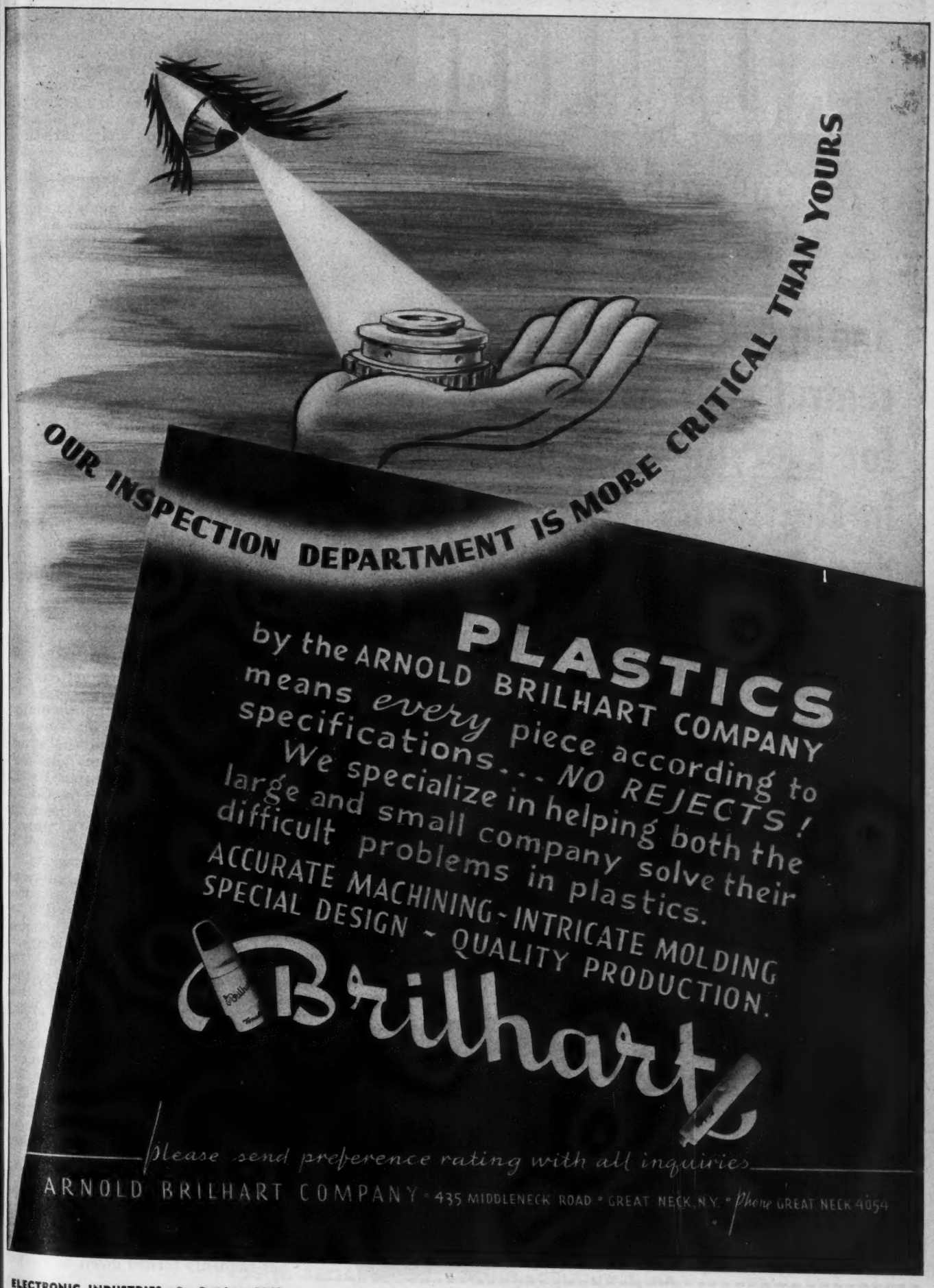
Let us assume that the motor is at rest and that the armature control is turned to a maximum position, that is line 20 connected to line 6. The grid of tube C will then be approximately 75 volts negative with respect to its cathode and no plate current will flow in R_2. Point 8 will then be near in potential to point 5. Under these conditions the grid of tube D will be positive, and full dc will flow through SRA, thus permitting full current to flow through tubes 1 and 4 to the armature.

If the speed control is now turned to its mid position, there will be a short time when the grid of tube C will be positive with respect to its cathode, permitting current to flow through R_2, thus bringing the grid of tube D negative with respect to its cathode and cutting off the current through the coil SRA. Thus the armature thyratrons are turned off until the speed has decreased to one-half of the full-voltage speed, at which time tubes C and D strike a balance to maintain 125 volts on the armature and to maintain this half speed.

IR drop compensation

If the speed is to be maintained constant when the motor is loaded at a low voltage and speed, it is necessary to increase the armature voltage to compensate for the internal resistance drop. Speed regulation curves of the effect of IR drop compensation are illustrated.

A current transformer with two primaries, one in the anode circuit of each armature thyratron, will produce in its secondary, a voltage proportional to the armature current. This voltage is rectified by tube F and a portion of this dc voltage is fed into the network between R_{10} and line 7, so that as the load on the motor increases the grid of tube C becomes less posi-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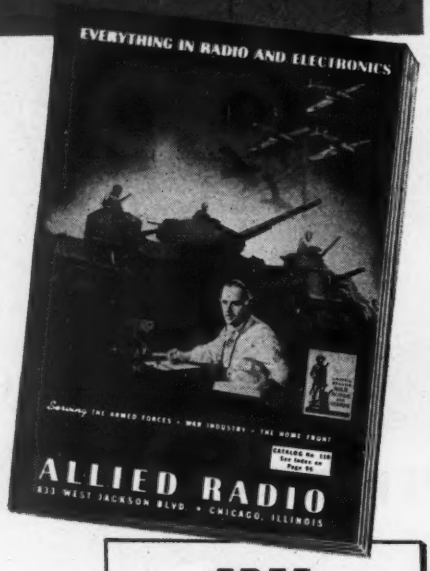

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tive with respect to its cathode. This results in tubes C and D maintaining a new balance at a higher armature voltage. The IR compensation adjustment is adjusted so that the armature voltage increases just enough to maintain the speed constant irrespective of load. The IR compensation can be adjusted, however, to give a rising or a dropping characteristic.

Current limit

Connected to the anode of tube C is also the anode of tube E. The grid of tube E is connected to a portion of the output of the same rectifier used in the IR compensation circuit in such a way that if the current exceeds a predetermined maximum, the grid of tube E will become positive and it will take control from tube C to limit the armature voltage and consequently the armature current.

During normal acceleration to a high speed, tube E has control until the motor is nearly up to speed; then as the current drops off, tube C takes over. In the event of a heavy overload on the motor, tubes F and E will operate through tube D and the thyratrons to reduce the armature voltage and maintain a fixed current limit until the thermal overload relay removes the motor from the line.

Field control

The field voltage is controlled in much the same manner as the armature voltage, with tubes CC and DD acting as the regulating tubes. The field circuit, however, differs somewhat from the armature circuit in that no field-compensation voltage is required when the load is increased and also in that current-limit strengthens the field through tube EE to provide full torque for starting as well as full torque during an overload.

Except under current-limit and voltage-limit conditions, the armature and field circuits are tied together only by the speed control potentiometers, two units connected mechanically in tandem. The speed control unit is made so that the first half of dial rotation controls the armature voltage of the motor, and the second half of rotation controls the field voltage. The armature circuit potentiometer has high resistance covering the first half of rotation, with a low-resistance unit covering the latter half. The field control unit consists of low resistance during the first half with high resistance in the latter half.

The anode of tube FF is connected to the anode of tube CC so that when the motor is running at a high speed and the speed control is suddenly turned down to a lower

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speed, the grid of tube FF becomes positive and takes control should the armature voltage become excessive under the full-field condition. This tube prevents full field being applied suddenly when the speed control is turned from top speed to low speed and thus prevents the motor from generating an excessive armature voltage.

Pre-conditioning on starting

When starting, it is desirable to have full field with reduced armature voltage to provide rated, or slightly above rated torque. Auxiliary contacts are provided on the line contactor to strengthen the field and to take care of this reduction. Before the regulator tubes have a chance to assume control, the circuit is thus prepared with full-field and reduced-armature voltage, and as the current-limit circuit takes control, the effect of the "pre-conditioning" circuit gradually disappears.

In addition to the electronic features, the following magnetic control devices are included: a cathode protective timer to insure sufficient heating of the thyratron tubes; a field-loss relay to shut the equipment down if a failure occurs in any part of the field circuit; an overload relay to protect the motor against sustained overloads; and anode fuses to protect the equipment during short-circuits. The necessary control devices to provide starting, stopping, conventional dynamic braking, reversing, jogging, or any special operating sequence can be added to suit the requirements of specific applications.

Features such as quick slowdown for high-inertia loads, follow-up between one motor and another, pilot-generator feedback for extremely precise speed regulation, and simplified circuits for fractional horsepower motors are only a few of the flexible features of Thy-mo-trol not mentioned in this article but representing variations in design applicable to special drives.

POSITIVE GRID OSCILLATORS

(*Continued from page* 78)

may have more than one possible mode of operation. Actually, as was noted by Scheibe and others, there may be several modes, all subject to coincidental stimulation. These individuals observed that their oscillators produced, under certain conditions, coexistent waves whose frequencies were nearly integral multiples of that of the normal wave. Because of the shortness of these secondary oscillations Potapenko[5] denominated them "dwarf waves," and investigated several

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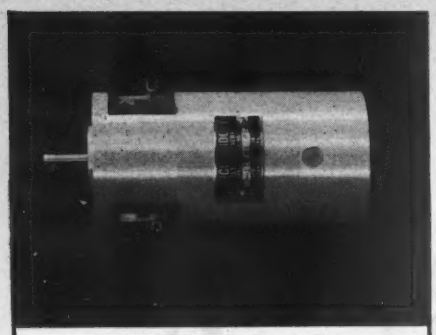

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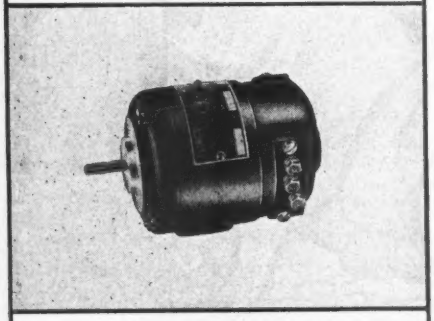

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orders thereof. While it might appear that these and harmonics are one and the same, such is not the case. Dwarf waves differ from overtones in that the former are completely independent of normal waves, this independence being experimentally demonstrable.

Optimum tube structures

Included among the observations of Barkhausen and Kurz was one stating that not all forms of triodes are suitable for use as oscillation generators. They came to this conclusion after making numerous experiments which showed that, of various tube types, only certain of those tubes having symmetrically arranged, cylindrical electrodes would function in an oscillator capacity. Analysis of structures of those particular cylindrical electrode triodes found usable gave rise to the inference that they differed from unusable ones in having elements which brought about establishment of regular and well balanced electric fields throughout the interelectrode space.

To these general observations were added later some of a more concrete nature by Sahanek[6]. From theoretical studies of the effects associated with variations in ratio of plate radius to that of the grid, and subsequent experimental studies confirming the theoretical, he concluded that for a tube to be well adapted to positive grid oscillator circuits it should have the ratio of its plate radius to that of its grid restricted to the limits

$$2.0 < \frac{r_2}{r_1} < 5.0$$

Here r_2 is the radius of the plate electrode and r_1 is the radius of the grid. According to a second conclusion drawn by Sahanek it would be possible for a tube whose grid were somewhat eccentric with respect to the plate still to act as an oscillator provided a certain limiting eccentricity were not exceeded.

A second factor relating to oscillator tubes that has practical significance is the gas pressure inside tube envelopes. Being proportional to the number of gas molecules therein it necessarily provides a measure of the molecular interference with electronic movements. Just how such interference is manifested in oscillatory changes has been made the subject of numerous investigations among the earliest of which were perhaps those of Grechowa[7], Kapzov[8], and Rindfleisch[9].

All three investigators, though working with pressures due to different elements (Grechowa and Rindfleisch concerned themselves mainly with residual gases, whereas Kapzov's study involved the use of mercury vapor), found both the

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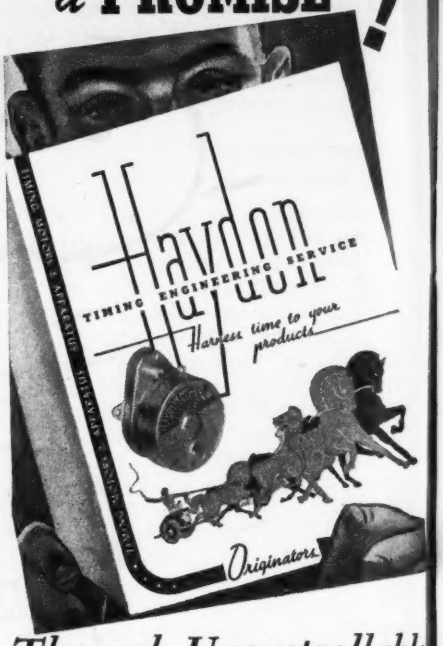

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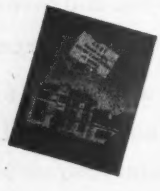

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wavelength and the oscillation intensity to be affected by such internal pressures of tubes.

In the case of Grechowa's work, for example, noteworthy changes in these two quantities were produced by pressures ranging from 5.0×10^{-8} mm Hg, up to 1.0×10^{-4} mm Hg. At a pressure of about 1.0×10^{-3} mm Hg a disappearance of the oscillations took place. Rindfleisch, again, in working toward the higher pressures observed that the starting point of oscillations was inclined to move to lower grid potentials, yet when pressures in excess of 5.0×10^{-4} mm Hg were reached all such tendencies likewise vanished.

Rindfleisch reported further that the presence of gas in a tube invariably leads to a lengthening of the waves produced. So far as oscillation intensities are concerned he pointed out, too, that maximum power is developed by tubes having high vacua, although pressures up to 5.0×10^{-5} mm Hg caused no appreciable diminution therein.

Grateful acknowledgment is made for the aid given to the writer by various members of the Physics Department staff of Iowa State College, especially Drs. P. H. Carr and J. W. Woodrow and Mr. L. E. Pinney, in the conduct of an experimental investigation from which were drawn the data underlying the illustrations presented herein.

[1]Barkhausen, H. and Kurz, K. Die kurzesten mit Vacuumrohren herstellbaren Wellen. Physikalische Zeitschrift. **21:** 1-6. 1920.

[2]Scheibe, A. Untersuchungen uber die Erzeugung sehr kleiner Wellen mit Gluhkathodenrohren nach Barkhausen und Kurz. Annalen der Physik. **73:** 54-88. 1924.

[3]Gill, E. W. B. and Morrell, J. H. Short electric waves obtained by valves. Philosophical Magazine. **44:** 161-178. 1922.

[4]Llewellyn, F. B. The Barkhausen oscillator. Bell Laboratories Record. **13:** 354-358. 1935.

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[6]Sahanek, J. Theorie der Erzeugung von sehr kurzen elektro-magnetischen Wellen mittels Elektronenrohren. Physikalische Zeitschrift. **26:** 368-376. 1925.

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[8]Kapzov, N. Uber die kurzwelligen Schwingungen von Quecksilberdampf enthaltenden Elektronenrohren. Zeitschrift fur Physik. **35:** 129-154. 1926.

[9]Rindfleisch, H. Uber die Einfluss von Gasen auf Barkausenschwingungen. Annalen der Physik. **14:** 273-298. 1932.

PRECISION INTERVAL TIMER

(*Continued from page* 95)

operation is needed, the internal balance of the circuit is such that the inaccuracy resulting from operation before stabilization does not exceed ±8 per cent of dial reading. A maximum error of less than 5 per cent after stabilization means that this timer must handle intervals correct within a few milliseconds under normal conditions.

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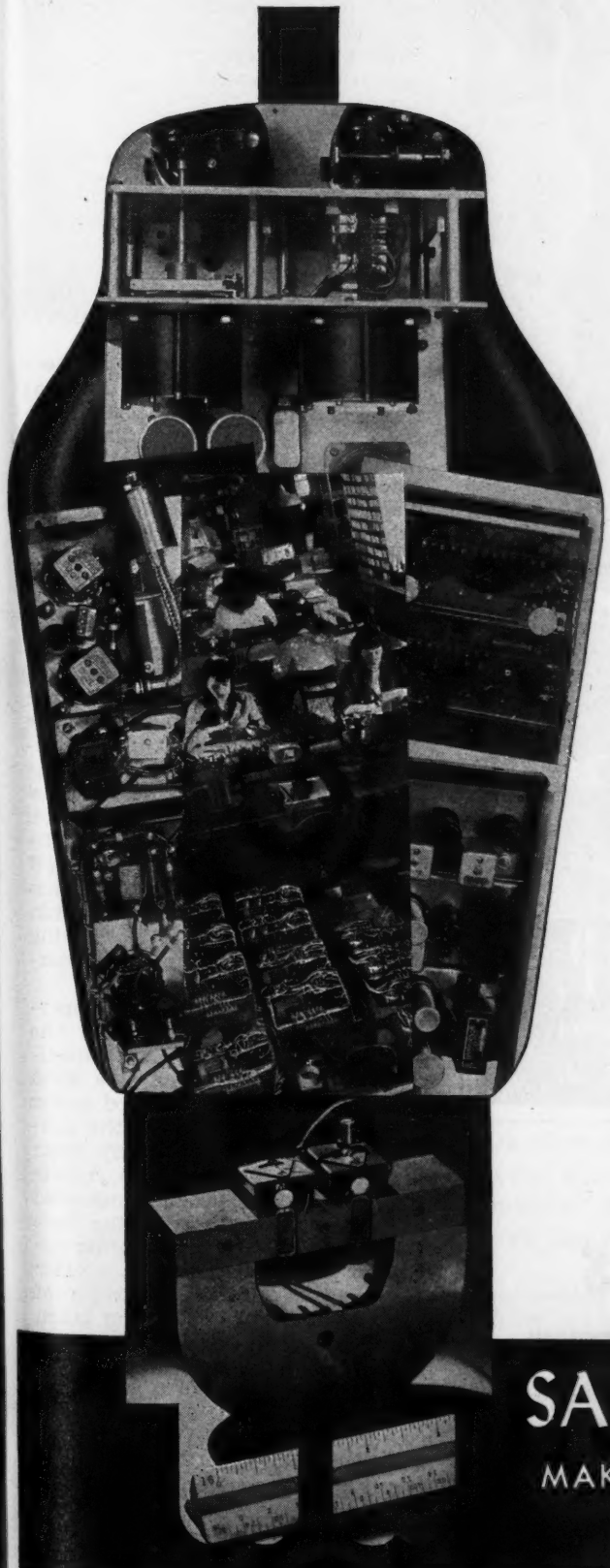

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tor circuit and incorporates certain individual design features which materially enhance its stability and reliable performance. The vacuum tube heaters are series connected through a suitable line ballast circuit designed to provide maximum tube heater life. Plate supply is provided by means of two separate half-wave rectifiers connected in a voltage-doubler circuit. Two gaseous voltage regulator tubes, connected in bridge fashion provide close voltage control over the wide operating parameters of the instrument.

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The chassis and cabinet of the timer, as well as all metal enclosed components are completely insulated from the power line circuit and will withstand a peak power line surge several times rated power line potential.

For time intervals up to 5.0 seconds, the right hand dial is set at zero selecting the time setting desired on the left hand dial. For time intervals of greater than 5.0 seconds the right hand or both dials are added together to the sum of the time settings indicated. For time settings in multiples of half seconds (.5 second) placing the .5 second toggle switch in lower right hand corner in ON position adds .5 second to the total time settings on the two selector dials.

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(*Continued from page 94*)

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Appendix

The general integral, S_N of equation (40) can be solved as follows[5]:

$$(1)\quad S_N = \left(\frac{1}{\sqrt{p^2+s^2}}\right)^{(4N-1)} I_N$$

Where (2) I_N

$$= \int_0^{\infty} \frac{dz}{(1-2z^2\cos 2\phi + z^4)^N}$$

The integral I_N is computed from:

$$(3)\quad I_N = I_{N-1} + \frac{1}{N-1}\left(\frac{u}{2} - \frac{1}{4u}\right)\frac{dI_{N-1}}{du}$$

$$- \frac{1}{64(N-1)(N-2)}\,\frac{1}{u}\,\frac{d}{du}\left(\frac{1}{u}\,\frac{dI_{N-2}}{du}\right)$$

(4) Where u

$$= \sin\phi = p/\sqrt{p^2+s^2}$$

(3) may be reduced by the use of auxiliary formulae for N = 2 and N = 1:

$$(5)\quad I_2 = I_1 + \left(\frac{u}{2} - \frac{1}{8u}\right)\frac{dI_1}{du}$$

$$(6)\quad I_1 = \pi\sqrt{p^2+s^2}\,/4p$$

4. J. R. Nelson, "Proceedings of the I.R.E., July, 1932.

DESIGNING AF FILTERS

(*Continued from page 73*)

duced to a positive or negative reactance in series or in parallel with R_o.

The insertion loss due to a reactance in series with input and output resistances R_i and R_o expressed in decibels is:

$$\alpha = 20\log\left[1+\frac{X^2}{(R_i+R_o)^2}\right]^{1/2}\text{db or}$$

$$\alpha = 10\log\left[1+\frac{X^2}{(R_i+R_o)^2}\right]\text{db}\quad(a)$$

The insertion loss in decibels due to a reactance in parallel with R_o is equal to:

$$\alpha = 20\log\left[1+\frac{R_i\,R_o}{(R_i+R_o)x}\right]^{1/2}\quad\text{or}$$

$$\alpha = 10\log\left[1+\left(\frac{R_i\,R_o}{(R_i+R_o)}\right)x^2\right]\quad(b)$$

In many applications such as operating into a grid of a vacuum tube, $\frac{R_i\,R_o}{R_i+R_o}$ is indetermi-

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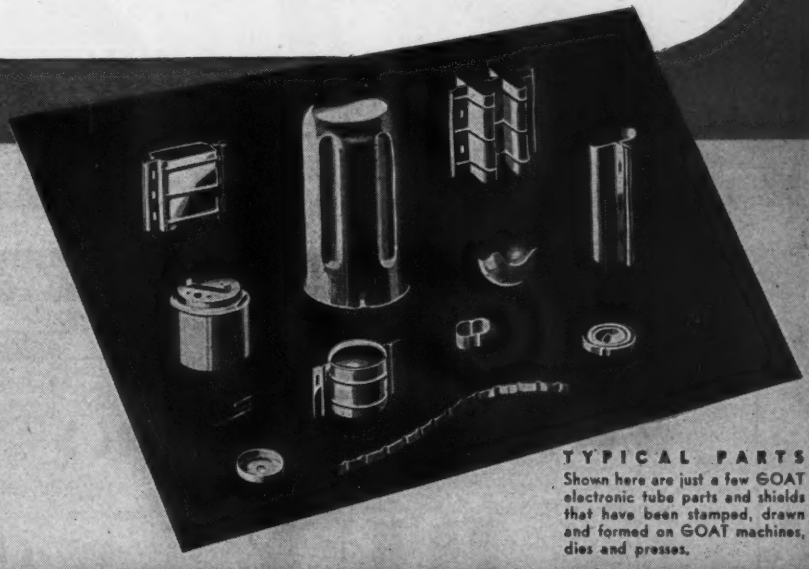

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nate as it reduces to $\frac{\infty}{\infty}$. Dividing the numerator and the denominator by R_o, this expression is reduced to $\frac{R_1}{\frac{R_1}{R_o}+1}$. When $R_o = \infty$, this expression becomes equal to R_1 and the equation (b) becomes

$$\alpha = 10 \log \left[1 + \left(\frac{R_1}{X}\right)^2\right] \text{ db.}$$

The insertion loss at any frequency, outside the resonant frequency, may be determined either mathematically from equations (a) and (b) or from the alignment charts in Figs. 5 and 6. The use of the alignment charts reduces considerably the time necessary for calculations so that several points on the performance curve may be rapidly determined.

Neither the equation (a) or (b), nor the alignment charts take into consideration the effect of dissipation in the reactors or condensers. This effect is pronounced near resonance only and is of little importance in the case of the band rejection circuits of Figs. 3 and 4. In the case of band-pass circuits of Fig. 1 and Fig. 2 it may be assumed that the total attenuation near the resonant frequency equals roughly the attenuation obtained from the alignment charts plus the insertion loss at the resonant frequency.

At the resonant frequency the LC circuit becomes, for all practical purposes, resistive in either the series or parallel combination; the resistance of the series circuit is $\frac{X_L}{Q}$, while that of the parallel circuit is equal to QX_L. The dissipation in the capacitor can usually be neglected, so that the Q of the coils only, enters into the calculations. The expression for insertion loss at resonance is given in Figs. 1 to 4.

Examples

To design a resonant circuit to pass a signal of a 1000 cps., with the second harmonic (or 2000 cps.) attenuated 30 db, assume the circuit is to work between $R_1 = 500$ ohms and $R_o = 1000$ ohms, and that coils with a Q of 40 are available. Either circuits Fig. 1 or Fig. 2 may be used to obtain the band-pass effect. Trying the circuit shown in Fig. 1, from equation (a) or from the alignment chart in Fig. 5, it is found that $X_1 = 4700$ ohms. From the relation $X_1 = X_L\left(\frac{N^2-1}{N}\right)$, and $N = 2$, we find that $X_L = 31200$ ohms. A coil having an inductance of 5 henries used with a capacitance of 0.0051 microfarads resonates at a 1000 cps. The insertion loss at the resonant frequency

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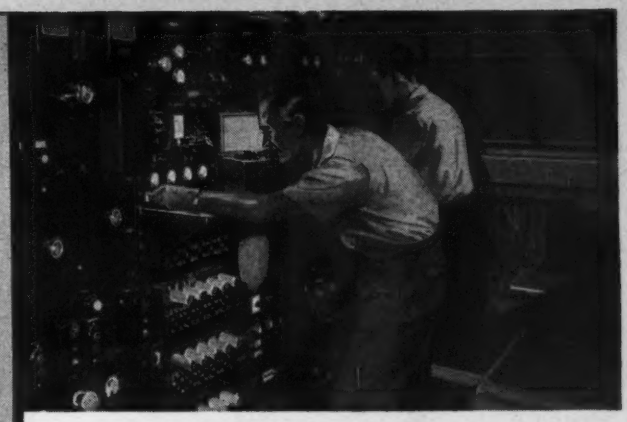

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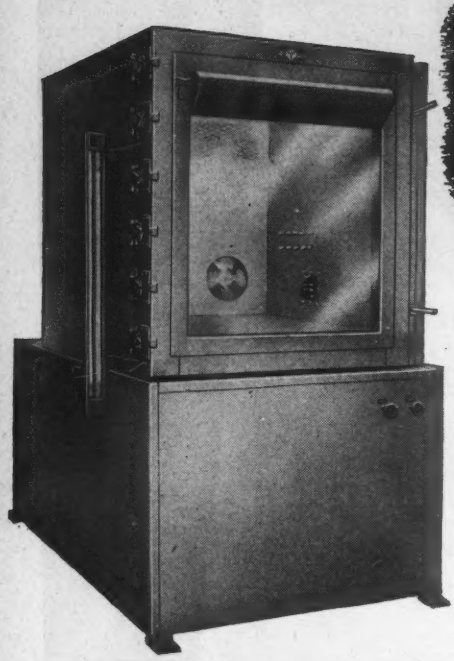

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Does it require minimum attention?
Does it bulk small yet have large capacity?
How much power is consumed in operation?
Does it meet critical specifications of the Army and Navy?
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is obtained from the expression (3) in Fig. 1 and is found to be 3.6 db. The attenuation at a few other points may be found, if it is so desired, by means of the alignment chart in Fig. 5.

If in some applications, the insertion loss at the pass frequency is limited, the design may be carried out with that point in view. For example, if the maximum insertion loss permissible at a 1000 cycles is 1 db, X_L is found from expression (3) in Fig. 1 to be 7800 ohms or 1.25 henries. The attenuation at 2000 cycles is then found to be 15.5 db.

If the parallel resonant circuit in Fig. 2 is to be used in the same circuit to obtain 30 db attenuation at 2000 cps, X_1 is found from either equation (b) or the alignment chart in Fig. 6 to be 10.5 ohms. From the relation $X_1 =$

$$X_L \left(\frac{N}{N^2 - 1} \right),$$

X_L is found to be 15.7 ohms or 0.0025 henry. A capacitor of about 10 microfarads is required. The insertion loss at the resonant frequency is found from relation (3) in Fig. 2 to be 3.6 db. Thus we see that it does not make any difference in this particular case whether series or parallel resonant circuits are used.

Inasmuch as the frequency response curve is symmetrical, the attenuation is the same at 500 as it is at 2000. Taking several points, the complete curve is rapidly determined.

Calculation of the band elimination network shown in Figs. 3 and 4 is carried out in a similar manner, with the exception that at the frequency to be suppressed, the circuit is resistive, and the attenuation is obtained from equation (3) Fig. 3 or Fig. 4. To illustrate, let us assume that it is desired to suppress 2000 cps using the series resonant circuit of Fig. 3, that $R_i =$ 500 and $R_o =$ 1000, the Q of the coil is 40, and that an attenuation of 30 db is desired. From equation (3) Fig. 3 we find that $X_L =$ 420 ohms or about 0.033 henry with a capacitance of 0.19 mfd to resonate at 2000 cycles per second. From the alignment chart of Fig. 6, the attenuation at 1000 cps and 4000 cps is found to be 1 db.

Selection of resonant circuit

The selection of the proper resonant circuit does not always depend upon the input and output impedances. We have seen from the example for the band-pass circuit that it does not make any difference whether the series or parallel resonance is used. However, when the parallel resonant circuit of Fig. 2 is used, a 10 mfd

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capacitor is necessary which is a rather bulky unit. Therefore the series resonant circuit of Fig. 1 is the logical one to use. So far as the reactor is concerned, it does not make much difference in size or Q whether it is 5 henries or 0.0025 henries of the second example. On the other hand, if the input and output resistances are large, the capacitor in the series resonant circuit might be small enough so that the winding capacitance of the coil interferes with the tuning. In this case the circuit of Fig. 2 is the one to use.

Another item of great importance is the effect of the resonant circuit upon other loads operating from the same generator. The parallel circuit of Fig. 2 acts as a low impedance at the low and high frequencies, and if other devices are operated from the same generator, their function is greatly impaired. In the same manner the circuit in Fig. 3 acts as a low impedance at the resonant frequency.

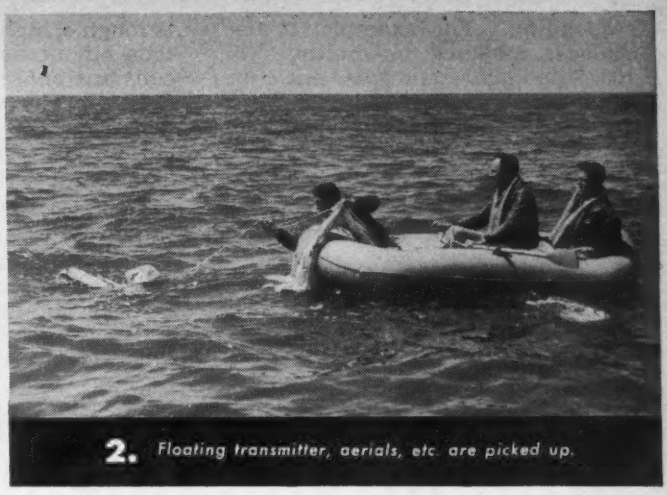
Transformers as tuned elements

The parallel-resonant circuit finds greater application compared with the series-tuned circuit because of its ability to act as an impedance or voltage transformation device in addition to being a tuned element. In cases where a line, or the plate of a triode operates into the grid of a succeeding stage, additional amplification is obtained by using a two winding step-up transformer. The tuning is obtained either from the secondary or primary side, whichever is more convenient as far as the capacitor's size is concerned. A good illustration of the use of a parallel resonant circuit employing impedance transformation is the previous example where a 0.0025 henry inductance is required to resonate with a 10 mfd condenser. The physical size of such a capacitor may be too large for practical purposes. An auto-transformer having an inductance of 0.025 henry, tapped at about 31.5 per cent could be used to resonate with 1 mfd condenser. The 31.5 per cent part of the winding is connected in place of the resonant circuit. In this manner a 10 mfd condenser may be made to appear as 1 mfd by means of a transformer, while the same transformer is also made a part of the tuned circuit.

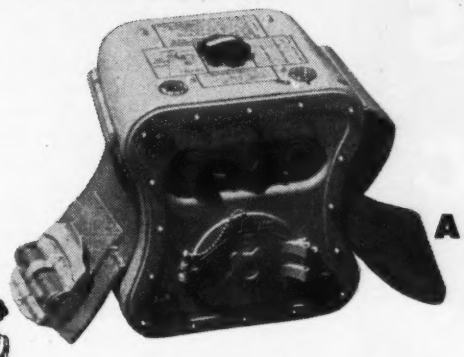
Alignment charts

In the alignment charts in Figs. 5 and 6 the left hand scale is graduated from 10 to 100 while that of the right hand scale is from 1 to 10. Any value may be assigned to either scale provided the value chosen for the other scale is cor-

1. *The Gibson Girl outfit is dropped from plane.*



2. *Floating transmitter, aerials, etc. are picked up.*



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FOR MEN ADRIFT

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THE GIBSON GIRL, during its development by Bendix Aviation, Ltd., North Hollywood, California, in collaboration with the Signal Corps Aircraft Laboratories at Wright Field, was nicknamed the *Gibson Girl* because of its hour glass contour. The name has stuck.

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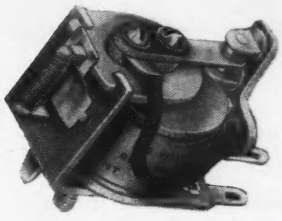

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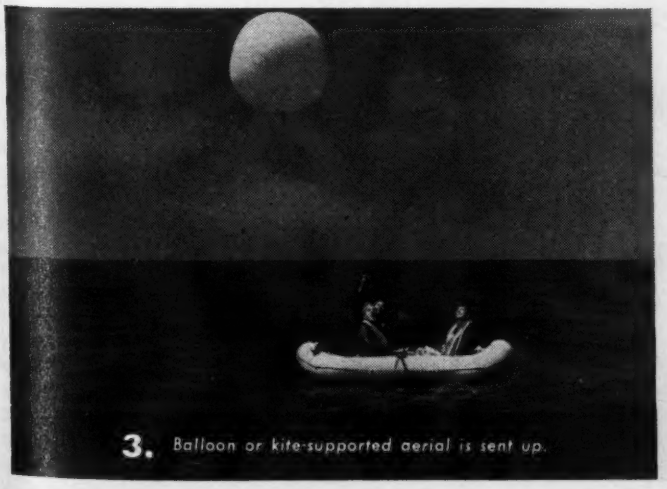


3. *Balloon or kite-supported aerial is sent up.*

4. *Turning crank automatically transmits S O S.*

responding. For example, if one scale is assigned in multiples of 100, the same multiple must be used for the other scale. In this manner the alignment charts may be used for any value of resistance and reactance.

The left hand scale of Fig. 5 is made in terms of $\frac{R_1 \quad R_o}{R_1 + R_o}$ This value represents the equivalent resistance of R_1 and R_o in parallel.

PROJECTILE VELOCITY

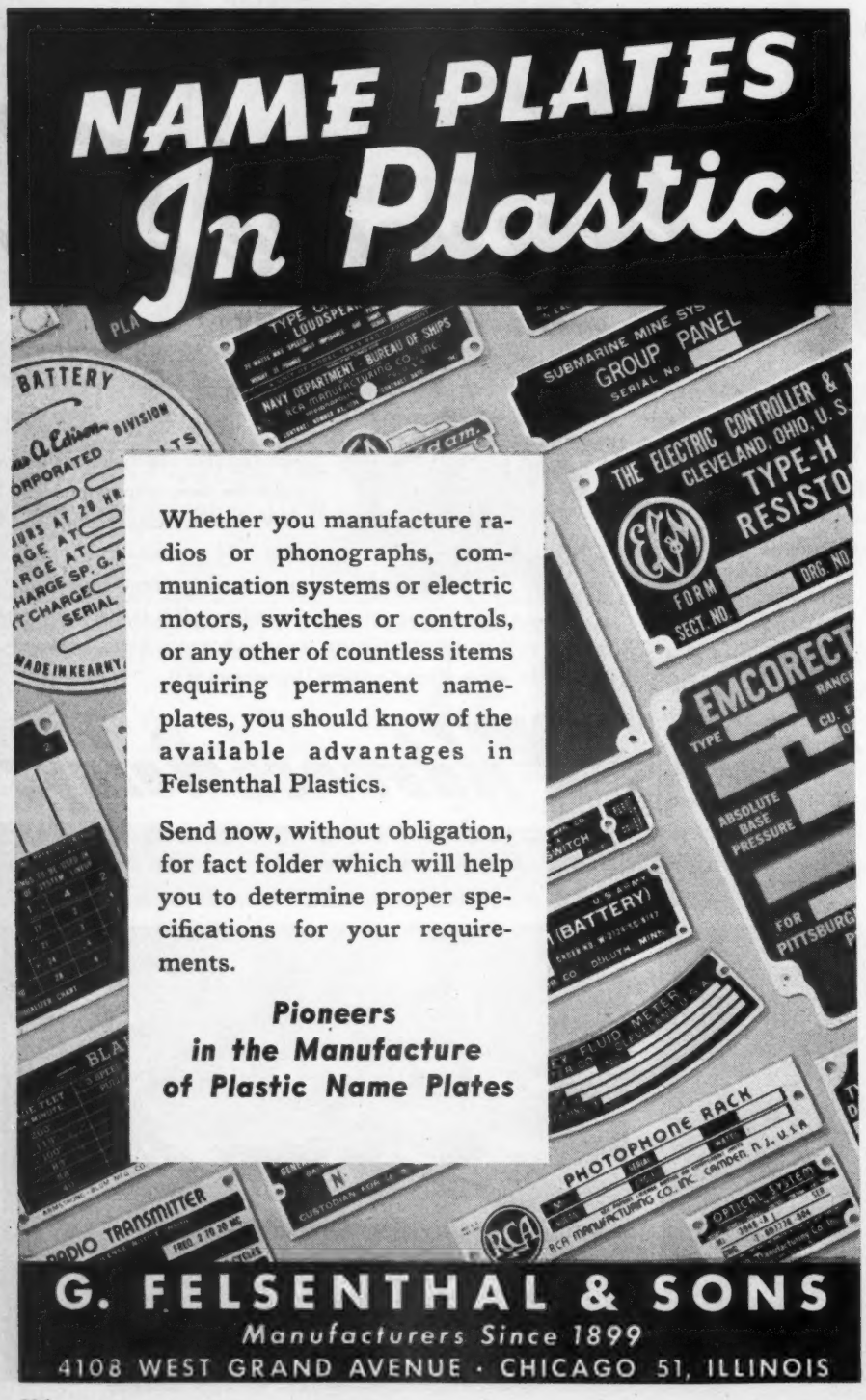
(*Continued from page* 67)

chronoscope illustrated. The principle of this instrument involves the charging of a capacitor through a highly degenerative pentode circuit designed to produce a constant charging rate of the condenser. The voltage on the condenser at the end of the interval is linearly proportional to the length of the interval.

An extremely high resistance voltmeter is used to measure the condenser voltage in order to avoid appreciable discharge of the condenser. The instrument is internally calibrating and has five scales which makes it possible to measure velocities over a wide range and over various distances. The time indication on the meter does not drift appreciably during the normal period required to read an indicating meter.

The coil disjunctor and two chronoscopes described were developed by C. I. Bradford of the Research Section, Remington Arms Co., Inc., and permit the overall accuracy of bullet speed measurement to be held well within 1 per cent.

Intervals ranging from 0.001 to 0.2 second are commonly measured. Small-arms bullet velocities average 2,800 ft. per second, or about 31 miles per minute. The larger projectiles travel somewhat more slowly. A 155 mm. shell, for example, has a velocity of 2,450 ft. per second.—G. S.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SEISMIC PROSPECTING

(*Continued from page* 65)

and gain vs. bias control voltage characteristics in order that the response of all channels be as similar as possible. The phase shift at 20 cps should not vary more than 10 deg. between channels.

Because of limited space available, the amplifiers must be as compact as possible. In portable equipment the weight and power consumption must be kept at a minimum.

Extensive precautions are taken in shielding chokes and transformers, minimizing microphonic noise in tubes, decoupling channels to avoid cross feed from common power supply, and minimizing the effects of leakage and danger, of failure of component parts due to humidity. (See Electronic Industries, Feb. 1943.)

Recording systems

The most popular type of recording unit is the moving coil galvanometer, although bifilar oscillographs and unifilar string galvanometers have been used. The records are made on moving photographic paper. Several of them are reproduced with this article. The mirror type galvanometer unit must be essentially flat in frequency response from about 20 to 70 or 80 cycles per second. An adjustable governor-controlled electric motor drives the recording paper at the desired speed. Since the essential information in seismic exploration is the elapsed time between the explosion and the reception of reflected ground waves, some means must be provided for recording elapsed time on the moving paper with an accuracy of at least one thousandth of a second. A number of schemes are in use, generally using a 50 cycle tuning fork with a low temperature coefficient. Means are provided to drive the fork and to project optically a sine wave or vertical line of light on the photo-

To the hams to the engineers to the technicians still in mufti to the old hands at the new games of war

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graphic paper at each half cycle of the fork swing.

A number of methods have been used to detect and record the instant of the explosive charge's detonation. This may be done by making or breaking an electrical contact at the site of the explosion, by detection of the sound waves, or by placing one geophone unit beside the shot-hole.

Power supply for the entire exploration unit is obtained from a storage battery or from a combination of A and B batteries. Plate supply may be obtained from a vibro-pack, motor generator, or from B batteries. Equipment is usually designed for minimum power consumption in the field.

Sound-on-film recording

An interesting variation in recording technique is the use of the Rieber "Sonograph," an instrument which records the returning wave energy as a series of variable area or variable-density sound-tracks on 35 mm. film. The film is then run through an analyzer unit which translates the tracks into the conventional wave traces on photographic paper. By reading the waves from each geophone in phonographically reproducible form, re-running this series of records is equivalent to repeating the shot, except that the circuit condition may be varied for each repetition.

By adding the reproduced waves algebraically, a directional sensitivity is conferred on the over-all performance. The axis of maximum sensitivity may be changed by varying the relative times of reproduction from the individual records before combining. Thus, the playback may be made responsive to waves from any desired direction, and insensitive to waves from other directions.

Faulted geological structures, unconformities and other complexities give rise to returned waves, often arriving from many directions at the same time. Recorded on the ordinary multi-trace oscillographic records, such wave-mixtures are so confused as to defy visual analysis. The sonograph can readily separate such complex patterns, thus opening for explanation considerable areas which may possibly be productive, but which cannot be explained by conventional means.

Prospecting methods

Two general types of ground waves can be detected near an exploded dynamite charge. First to arrive at the receiving point are the refracted waves, which penetrate to the first layer or medium of low impedance, travel rapidly through it, and are then transmitted back to the surface to actuate the geophones.

The earliest method of seismic exploration made use of this phenomenon exclusively. The receivers were placed at some distance, perhaps up to five miles, from the shot-point, which consisted of a rather heavy charge up to 10 tons. Reception of several refracted waves at different intervals gave clues to the existence of media of higher than average velocity between the shot-point and the receiver. A number of receivers were frequently placed in a circle surrounding the shot-point in what was known as "fan shooting." A salt dome, one of the most common oil structures in the Gulf region, between the shot-point and any geophone on the circle would result in reception of the first wave at that point considerably ahead of the reception by the other pick-ups. Simultaneous starting of all receivers was frequently done by radio control from the shot-point.

Refraction shooting has been almost replaced by reflection shooting, the method in which a portion of the energy from the descending pressure wave is reflected back to the surface by each layer of dif-

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This is just one example of problems taken in stride by Magnavox engineers, creating and manufacturing military equipment ranging from solenoids to the most intricate types of complete radio communication systems.

Magnavox brings to the war effort the skill and "know how" developed by 32 years of designing, engineering and manufacturing for the radio industry, plus the splendid facilities of the completely modern new six acre plant, finest machine tool equipment and the production economies of efficient management. The Magnavox Company, Fort Wayne 4, Ind.

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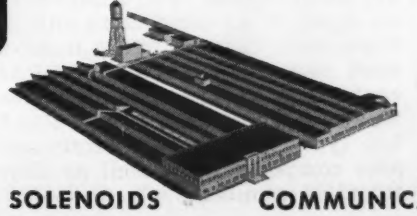

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ferent density or velocity encountered. The study of seismic waves has rapidly become a highly specialized field. Their interpretation with a view to locating oil is both a science and an art.

Conclusions

In surveying the over-all results of the use of seismic prospecting, it should be borne in mind that each year the location of deposits of oil remaining in the earth becomes more difficult. During the early days of oil, only about 6 per cent of the wells drilled by haphazard wildcat methods actually succeeded in producing oil. At the present state of the art of seismic prospecting, nearly 20 per cent of the wells drilled are producers. The best modern geological methods, used without seismic aid, are much less successful.

The successful figures for seismic prospecting are not startling per se. However, early oil wells were shallow. The average wells today are from 6,000 to 10,000 ft. deep. The amount of oil produced by each well must also be taken into consideration. If we divide the total number of barrels of oil produced in this country up to the present time by the number of wells drilled — whether dry or producers — we find an average of 180,000 barrels of oil per hole. During the past five or six years, however, with the advent of efficient seismic exploration methods, we find an average of better than 300,000 barrels for each hole drilled.

More heartening still, from the standpoint of the nation's oil reserves, is the fact that seismic prospecting with electronic methods is a young field. With the ever-increasing demand for more oil-producing lands, the development of the art will almost inevitably preceed at an even greater rate than in the past.

*Jakosky, J. J., Exploration Geophysics, Times-Mirror Press, Los Angeles, Calif. Heiland, C. A., Geophysical Prospecting, Prentice Hall, N. Y. C. Nettleton, L. L., Geophysical Prospecting for Oil, McGraw Hill, N. Y. C.

Cannon Visual Aids

A pair of valuable wall charts (four by three feet) have been produced by Cannon Electric Development Co., Los Angeles, to be used as visual aids for instruction purposes and also for practical shop and servicing use. They will also serve as ready reference guides for engineering departments. The charts cover all types of AN connectors and include such data as figure number, shell size and dash number, total contacts, wire sizes and service designations. Illustrations show standard types, parts and interchangeable components, as well as identification numbers.

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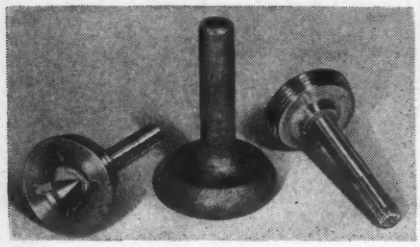

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Other associated companies are Investment Corp. of North America, Schwarze Electric Co., Stanley & Patterson, Inc., Victory Products & Mfg. Corp., and Marquette Food Industries.

Van Norman Machine Tool in Induction Heating

Van Norman Machine Tool Co., Springfield, Mass., which since its inception in 1912 has been an important producer of machine tools and particularly of automotive service equipment, has recently taken up the production of induction heating equipment. As a means toward indicating the enlarged scope of its operations, the name of the company has been abbreviated to Van Norman Co.

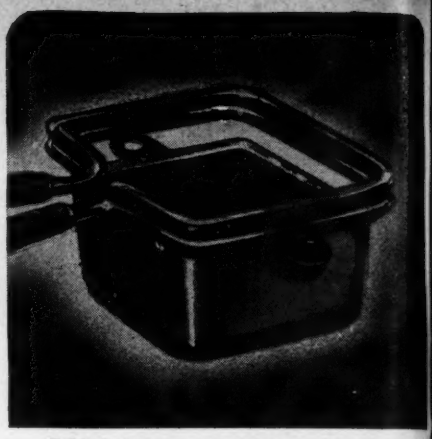
Clarostat Centralizes Offices

Marking another phase of its rapid expansion, Clarostat Mfg. Co., Inc., manufacturer of resistors, controls and resistance devices, has moved its general offices to 130 Clinton St., Brooklyn, N. Y.

Recent expansion has necessitated larger quarters for the general offices which now occupy the entire ninth floor of the modern office building and consolidate all business departments heretofore spread out in the three plants. This latest expansion follows close on the opening of the third plant last spring. All Clarostat plants are located in the Greenpoint section of Brooklyn.

Electronic Automatic Pilot

The Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., for some time in production on an electronically-controlled automatic pilot for bombers, has made public the purpose of the equipment, though details remain a carefully guarded military secret. The purpose of the device is to take over control of a bomber and automatically maintain flight straight and level during the bombing run. The electronic automatic pilot, accepted by the Army Air Force as long ago



Soldering seams on metal cans—either ferrous or non-ferrous metal—with Lepel High Frequency Induction Heating.

SOLDER IT IN A Fraction of the Time AT A FRACTION OF THE COST

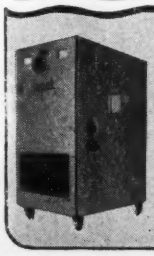
If you have a production soldering job, a relatively inexpensive Lepel High Frequency Heating Unit will do it in a fraction of the time required by other methods—and at a fraction of the cost.

It will also do a neater job, save solder and permit use of any soldering alloy from lowest to highest melting point.

Yet it is so simple, dependable and clean that many installations are operated entirely by women.

The same unit, manually or automatically operated, can also be used for brazing, hardening, annealing, stress relieving, bombarding and melting of all metals. It is readily convertible from war production to peacetime applications at practically no expense.

Send samples of your work with specifications for complete engineering data and recommendations. Write for catalog.



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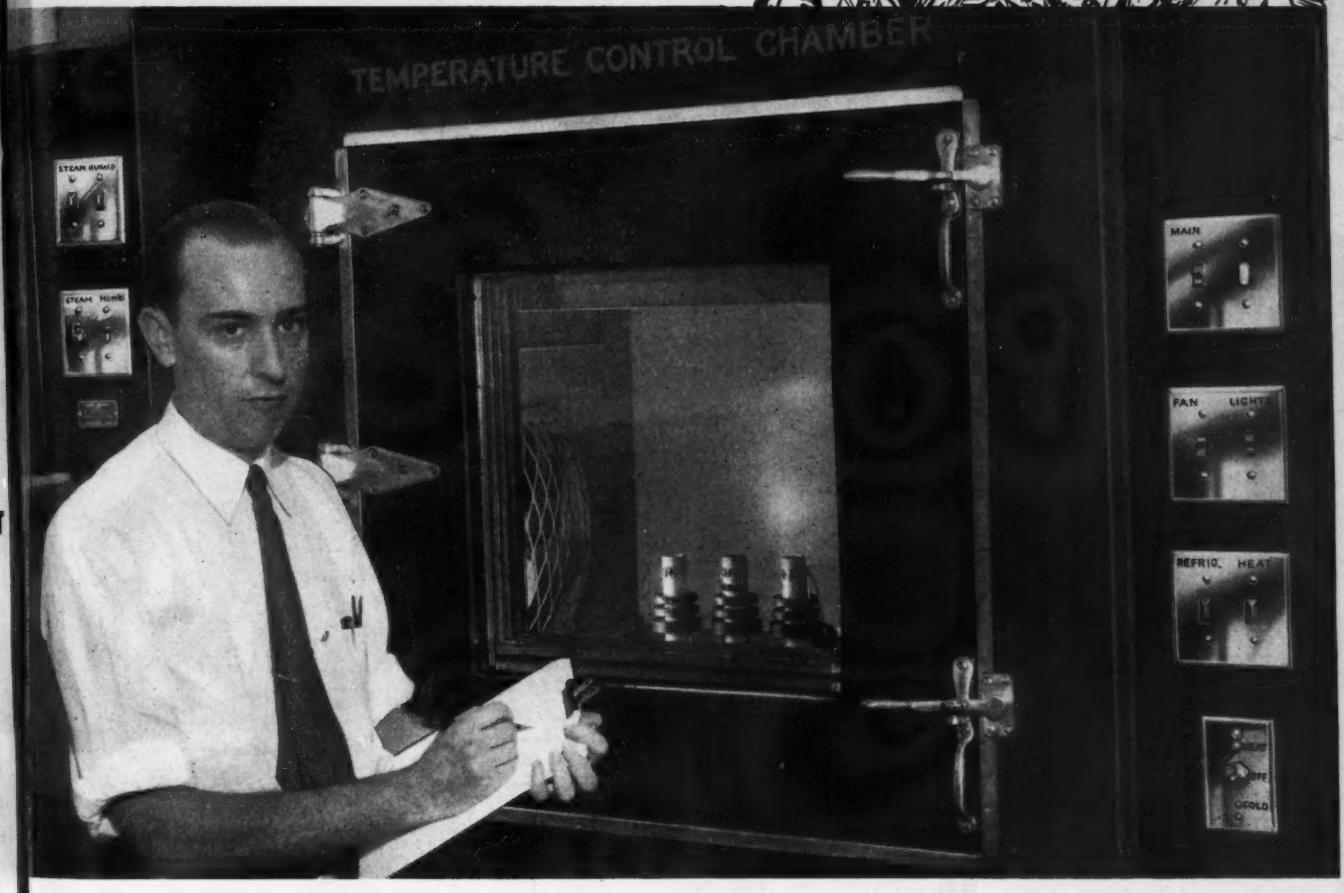
The Jungle . . .



that came to New England

In use, Sickles electronic specialties accompany the Allied armed forces into every extreme of climate—steaming tropics, burning deserts, frozen northlands . . . on land, sea, and in the air. So to help make sure that our products continue to *exceed* the rigid specifications of government procurement agencies . . . to *know* that they'll stand up in service . . . we've brought the jungle to Chicopee, and the arctic and desert as well. This hot-cold, wet-dry box duplicates conditions under which Sickles products must operate. It's part of Sickles unusually complete testing laboratory . . . one more reason why you'll benefit by specifying Sickles coils, condensers, and other units when Victory is won.

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And if required items are not in stock, DALIS go-gets 'em for you in shortest possible time.

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as October, 1941, functions to provide a stable bombing platform upon which the possibility of precision bombing depends. Operation of the device is controlled by the bombardier.

Dave Grimes Killed in Airplane Crash in Ireland

David Grimes, vice-president in charge of engineering for Philco Corp., who was abroad on a special war mission, was killed on Saturday, September 4, when the transport plane in which he was traveling with Commodore James A. Logan, Commandant of the United States Naval operating base at Londonderry, crashed into a mountain in Northern Ireland. He was 47 years of age.

Grimes served in the last war as chief radio officer at Kelly Field, Texas, when the use of radio in warfare was just beginning to assume importance. From June to December, 1918, he was Signal Officer attached to the British Air Forces at Aldershot and Littlehampton, England.

After the war, he joined A. T. & T. as a research engineer in telephony. In 1922 he established his own engineering organization to do research work on a consulting basis for a number of different companies. It was during this period that he invented the famous "Grimes Inverse Duplex circuit" that was used by many early radio amateurs in home-made receivers. From 1930 until 1934, he was license engineer with the Radio Corp. of America.

Mr. Grimes joined Philco in 1934 as engineer in charge of home radio-set research and engineering, and continued in that capacity until 1939, when he was named chief engineer. In 1942 he was elected vice-president in charge of engineering.

Among Dave Grimes' many unusual abilities, he possessed a delightful platform presence, and whenever he was called on to address a meeting, the interest of either technical or lay audience was sure to be held until the very end, both by his flow of ideas and by his subtle and effective humor.

Friend Joins Curtiss-Wright

H. H. Friend, until recently associated with Scintilla Magneto division of the Bendix Aviation Corp., is now development engineer of electronics, airplane division department, of the newly formed Development division, Curtiss-Wright Corp., Bloomfield, N. J.

Anti-Climax Department

Reports that revered technical journal "Scientific American" in its September issue: "Electronics' brightest star, a demonstration of popping corn without heat."

ENGRAVING
ON
METAL, PLASTICS
AND
STEEL STAMPING
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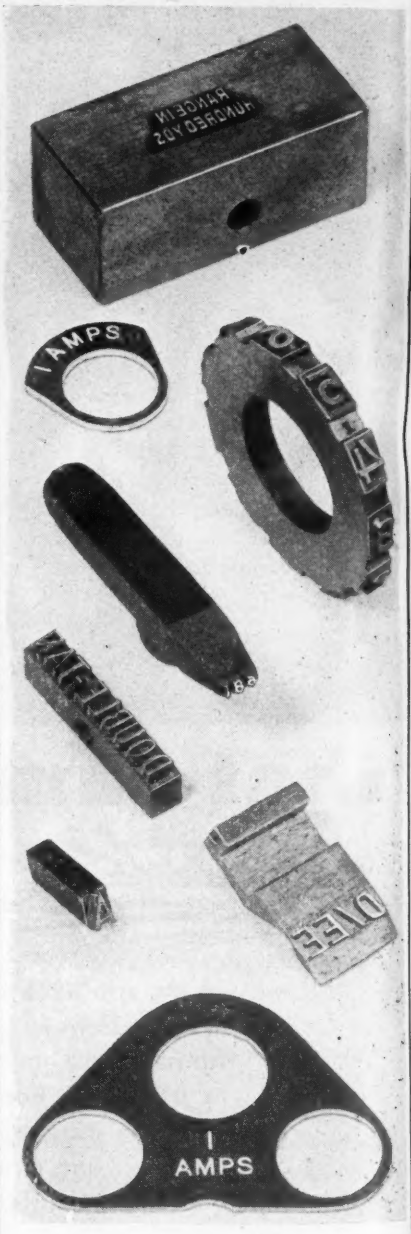

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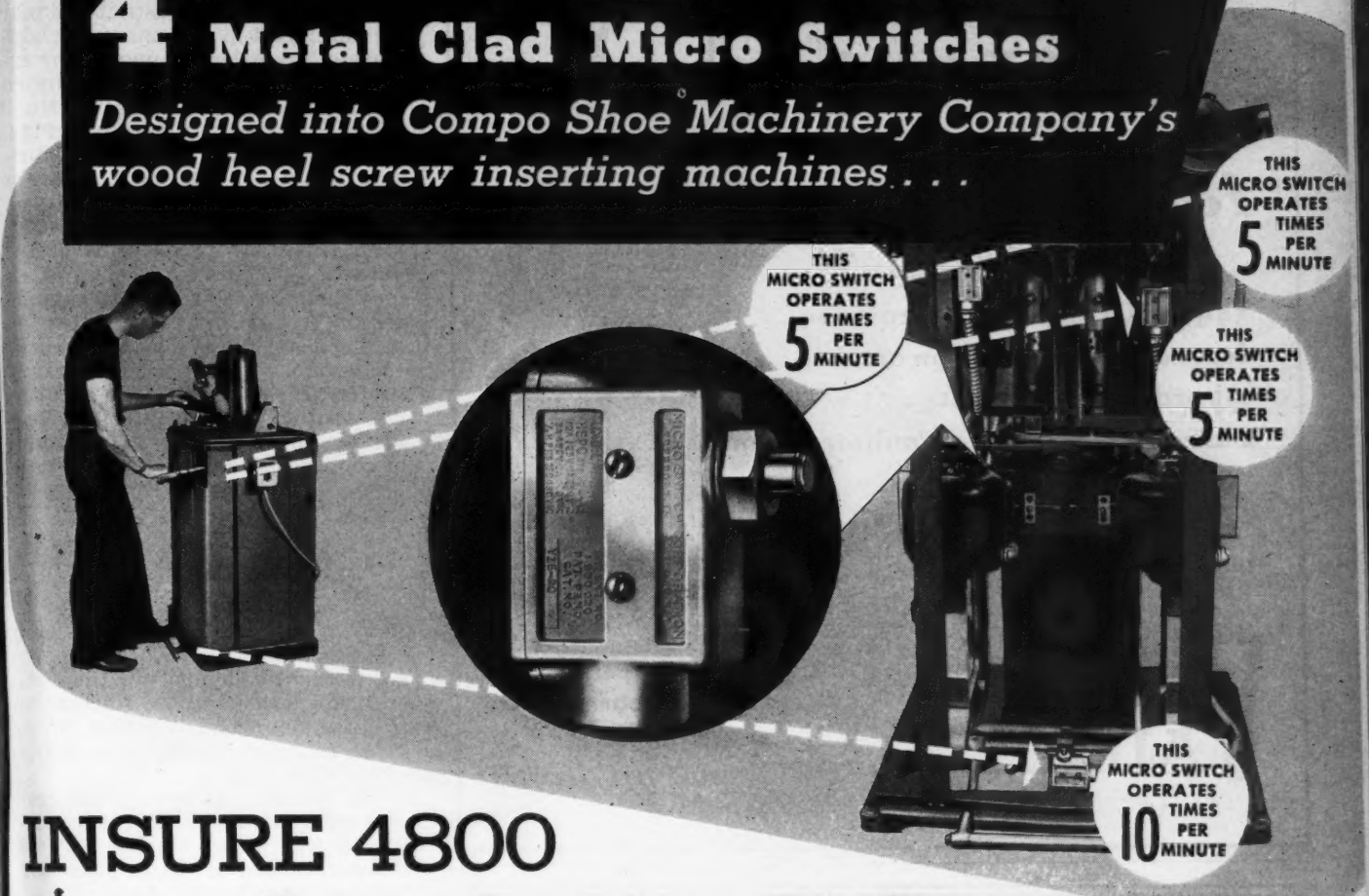
4 Metal Clad Micro Switches

Designed into Compo Shoe Machinery Company's wood heel screw inserting machines . . .


THIS MICRO SWITCH OPERATES 5 TIMES PER MINUTE
THIS MICRO SWITCH OPERATES 5 TIMES PER MINUTE
THIS MICRO SWITCH OPERATES 5 TIMES PER MINUTE
THIS MICRO SWITCH OPERATES 10 TIMES PER MINUTE

INSURE 4800

Accurate Repeat Operations Per Day

Compo Shoe Machinery Company, Boston, Mass., for six years has found the four Micro Switches, designed to control the exacting operations of their wood heel screw inserting machines, give excellent results.

These machines which are used to permanently attach wooden heels to lasted shoes have one Micro Switch, connected with the foot pedal, that operates ten times a minute, and three other Micro Switches that are used five times a minute . . . every working day.

1. When the foot pedal of the machine is depressed, a *Micro Switch* action raises the clamping head, allowing the operator to place the shoe on the last seat.
2. When the operating handle is actuated, a normally closed *Micro Switch*, held open in the idle position, is released, energizing a magnetic contact which operates the drill motor. When the drill reaches exactly the desired depth, a friction finger is set so that the driver spindle can be stopped at the proper point in the next operation.
3. After the clamping head is swung to the driving position, the handle is again actuated, this time moving the screw driver spindle and closing a normally opened *Micro Switch*. Although closed but momentarily; this Micro Switch energizes a magnetic contactor which is held closed by another *Micro Switch*.
4. When the screw has been driven to the correct depth, the friction finger contacts the *Micro Switch*, breaking the circuit to the contactor and stopping the driving motor.

Compo Shoe Machinery Company has not only found that Micro Switches give them the precise accuracy demanded in these machines, but say that savings in service time and original cost are quite appreciable. These switches stand up on the average for two years of constant service.

If you have a design that calls for the unusual in precision switching, that is where Micro Switch can help you. Small and compact in size, with small movement and operating force, many types of housings and actuators, Micro Switch is easily adapted to your specific application.

Write for Micro Switch Handbook Catalog No. 60 for full information on Micro Switch. If you happen to be specializing in aircraft design, you also should have Handbook Catalog No. 70.

The trademark MICRO SWITCH is our property and identifies switches made by Micro Switch Corporation

Micro Switch Corporation, Freeport, Illinois
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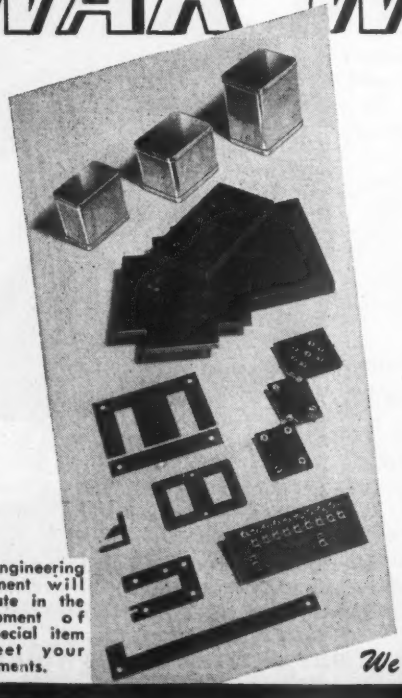

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Turret lathe, automatic screw machine parts and products from bar stock to castings

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Copper Wire Available

Copper wire for sale to the general public without restrictions may be purchased in amounts up to $100 during any calendar quarter by retailers, electricians, radio repairmen and others under Regulation No. 9 of the Controlled Materials Plan, issued Sept. 10 by the War Production Board. If more copper wire is needed by a retailer or repairman, he must determine as accurately as possible the dollar value of the wire he sold during 1941, and he may then buy in any calendar quarter one-eighth of this amount. In selling copper wire under the new regulation, retailers need heed only preference rating AAA or a farmer's certificate under Priorities Regulation No. 19. Three million pounds of copper per calendar quarter have been earmarked for this program.

G-E Appoints Three

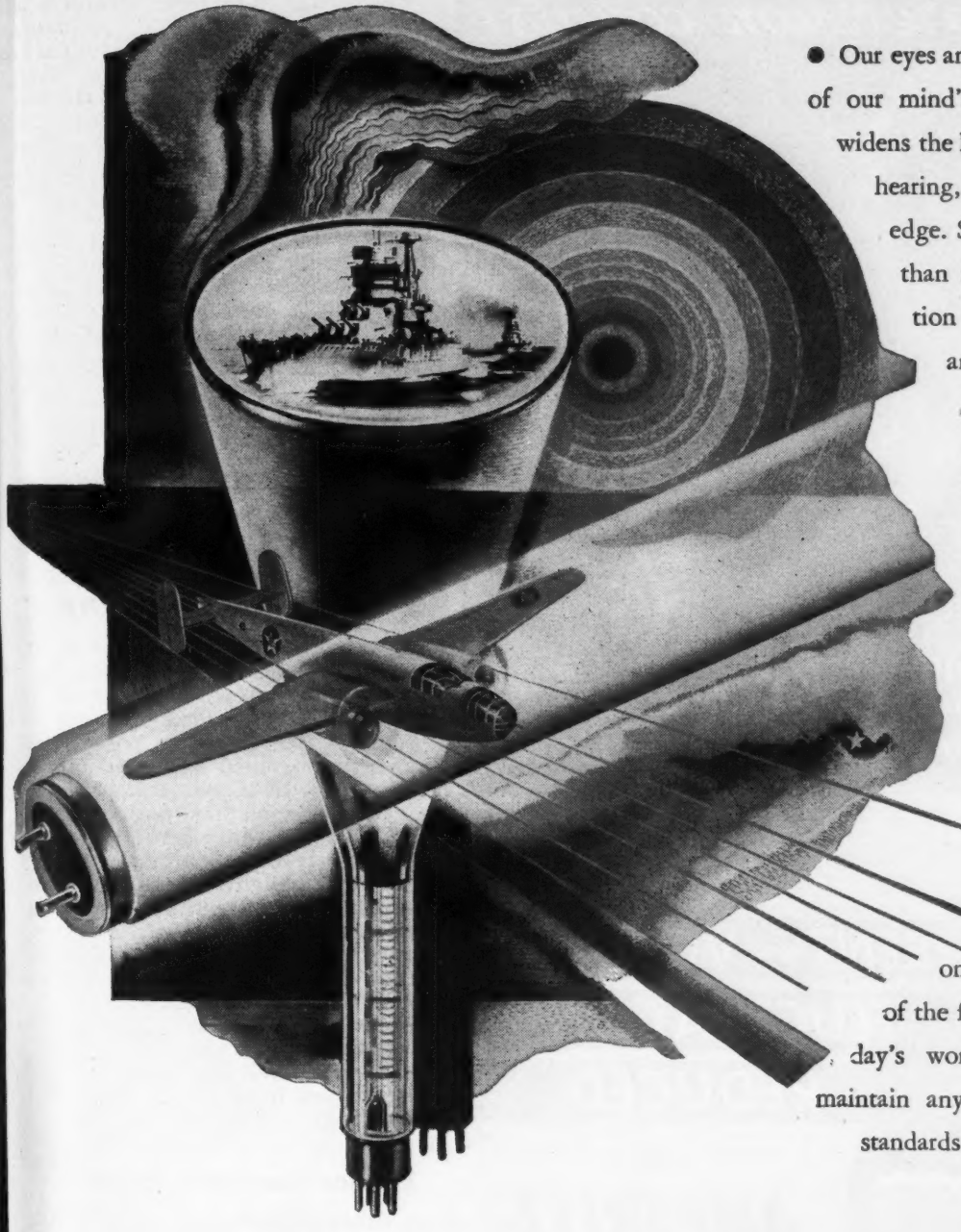
Arthur A. Brandt, George W. Henyan, and V. M. Lucas have been appointed in new positions in the electronics department of the General Electric Company, according to an announcement by Dr. W. R. G. Baker, vice-president in charge of the department.

Mr. Brandt has been made general sales manager. In this capacity he will be responsible for the coordination of the sales plans and policies of the several divisions, and the operations of the electronics department district offices.

Mr. Henyan has been made assistant to the vice-president of the department, and Mr. Lucas has been appointed manager of the Government division.

Arthur A. Brandt, newly appointed general sales manager, electronics department, General Electric Co.

To see and hear beyond the beyond

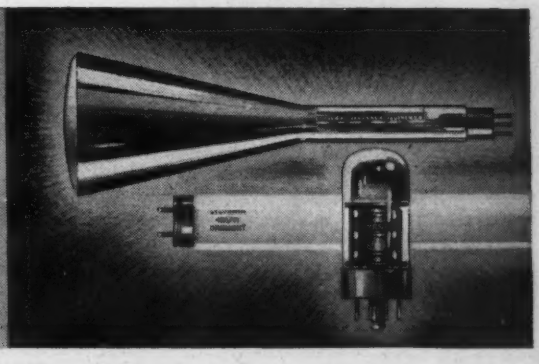


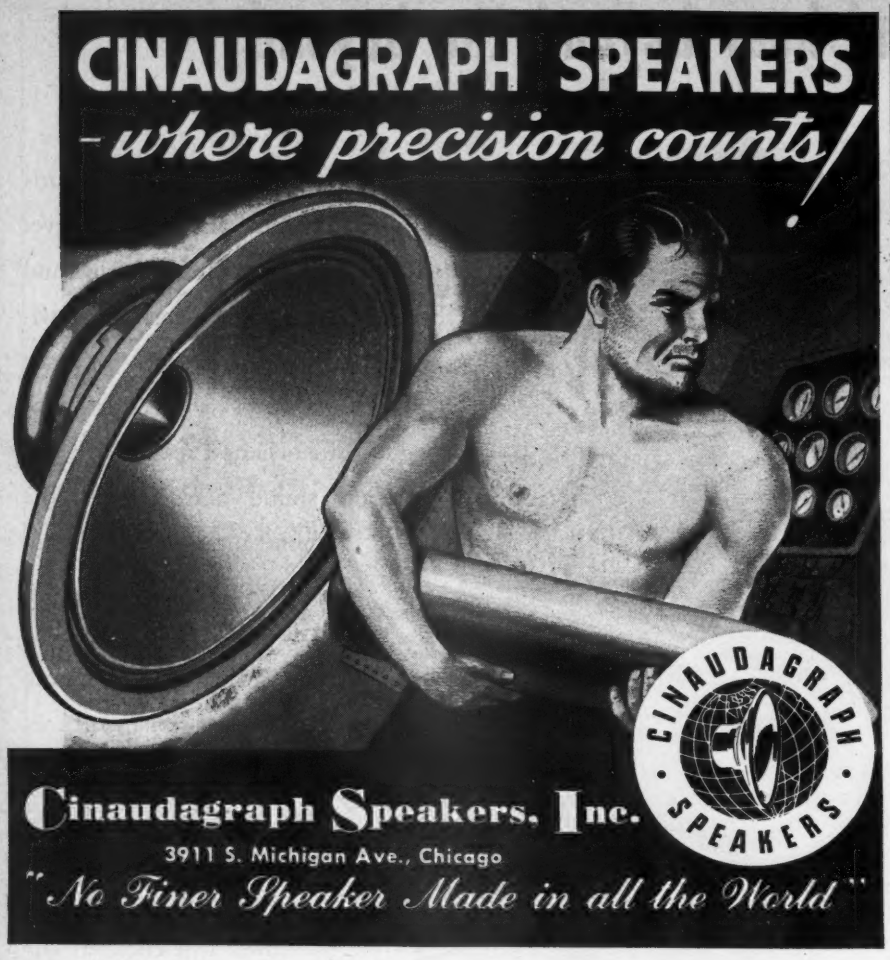
● Our eyes and ears are the advance guards of our mind's march forward. Whatever widens the horizons of human vision and hearing, reveals new vistas of knowledge. So our chosen work for more than forty years has been exploration of uncharted realms of sight and sound. Starting with the humble incandescent lamp, progressing to radio and electronic tubes, fluorescent lamps and equipment, we are today busy with ventures which are contributing vitally to the winning of the war. And important as these may be to Victory, their full flower will come as enduring boons to better living in the years beyond. How could anyone, glimpsing the rich promise of the future, be content to do each day's work with a firm resolve to maintain anything less than the highest standards known!

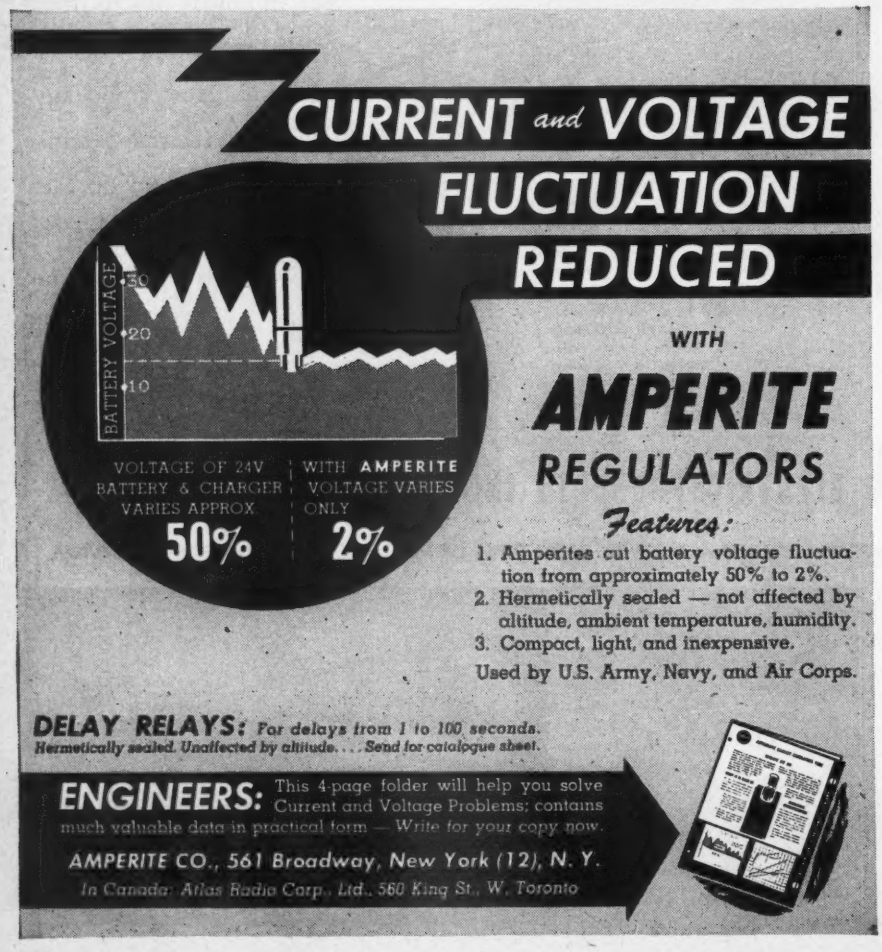
SYLVANIA ELECTRIC PRODUCTS INC., EMPORIUM, PA.

MAKERS OF INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, RADIO TUBES, CATHODE RAY TUBES AND ELECTRONIC DEVICES

VITAL TO VICTORY is the ever-increasing number of electronic devices that miraculously bridge the gap between man and the machine tool in war industry. Electronic contributions to technology make inspection and processing more automatic and foolproof. From long experience, Sylvania has developed and applied electronic tubes to industrial as well as military uses.



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Mallory Workers' "Determination, Ability"

P. R. Mallory & Co., Inc., Indianapolis, has just been awarded a third star for the "E" pennant, which was first won in January, 1942. At the request of the Navy Department, no ceremonies are being held in connection with the star award. In commenting on the new honor, Admiral C. C. Bloch, Chairman of the Navy Board for Production Awards, wrote:

"The men and women of P. R. Mallory & Co., Inc., have achieved a signal honor by continuing their splendid production in such volume as to justify this renewal of their award. In the first instance, it was difficult to win the Army-Navy 'E' and by meriting a third renewal, the management and employees have indicated their solid determination and ability to support our fighting forces by supplying the equipment which is necessary for ultimate victory."

Terrell Honored by FDR

Marking the retirement of W. D. Terrell as chief of the field division, Engineering Department, Federal Communications Commission, sixty-eight of his associates, co-workers and friends held a dinner in his honor at the Lee-Sheraton Hotel, Washington, on the evening of August 31st, the effective date of Mr. Terrell's retirement.

The highlight of this dinner, which was replete with expressions of good wishes and felicitations, was the presentation of a letter from the President of the United States, conveying to Mr. Terrell the nation's thanks and gratitude for his 40 years of service to radio. "You can well be proud of the record you have made," wrote the President.

Turner Succeeds Terrell

George S. Turner has been named chief of the Field Division of the Federal Communications Commission. He succeeds Wm. D. Terrell who retired from government service after 40 years work in the communications field. Mr. Turner has been assistant chief of the division, having joined FCC in 1931 as inspector in charge at Atlanta.

Hundred Million Volts

One hundred million volt X-rays were produced for the first time late in August by the Research Laboratory of General Electric Co., Schenectady. Producer of this high potential was the new electron accelerator recently completed. A complete report is to be published shortly.

Eimac gets another "E"

Mass production of a device that has always been hand made in a laboratory is an achievement in itself. But when the whole nation gives pause to *recognize outstanding excellence in this mass production* the achievement becomes all the more striking.

Such honors have been bestowed upon the Eimac organizations not once but twice. First to the San Bruno, California, plant (September 1942) and second, less than a year later, to a plant in Salt Lake City, Utah, that is little more than one year old.

Where does the credit go? . . . to the men and women at the Salt Lake City plant now for their recent triumph . . . and to the men and women of both plants always for their collective cooperation and hard work.

Follow the leaders to Eimac REG. U.S. PAT. OFF. TUBES

EITEL-McCULLOUGH, INC, SAN BRUNO, CALIF.

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POWERSTAT Motor Driven Variable Transformers were pioneered by SECO. The engineers of Superior Electric Company have developed the only Motor Driven Variable Transformer having the features of

(a) Simple drive — no complicated gearing.
(b) Precise stopping when motor is de-energized, eliminating hunting and overshooting.
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For precise, simple control of AC power with automatic or push-button operation specify Motor Driven POWERSTAT Variable Transformers.

Send for Bulletins: 149 IE - POWERSTATS — 163 IE - Voltage Regulators

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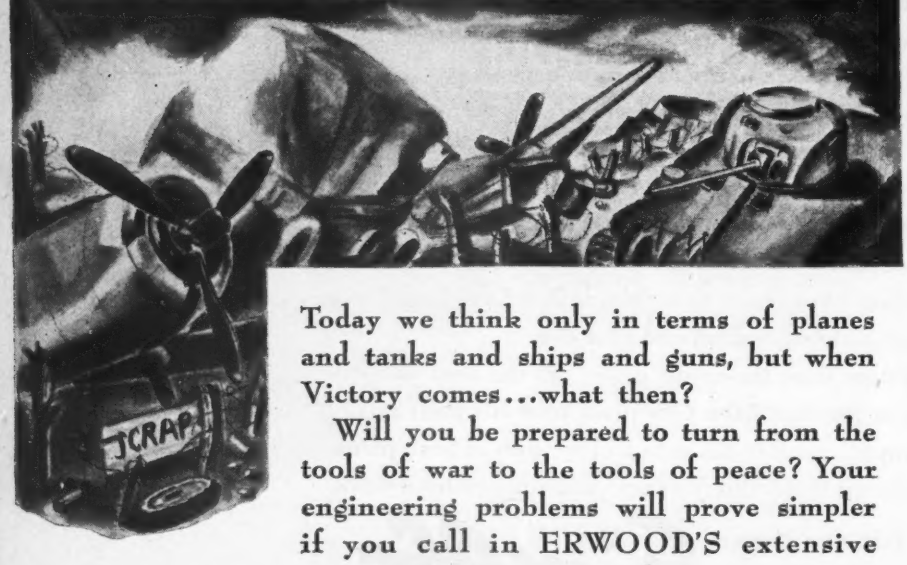
SUPERIOR *Electric Company*

The morning after Victory...



Today we think only in terms of planes and tanks and ships and guns, but when Victory comes...what then?

Will you be prepared to turn from the tools of war to the tools of peace? Your engineering problems will prove simpler if you call in ERWOOD'S extensive experience to your aid.

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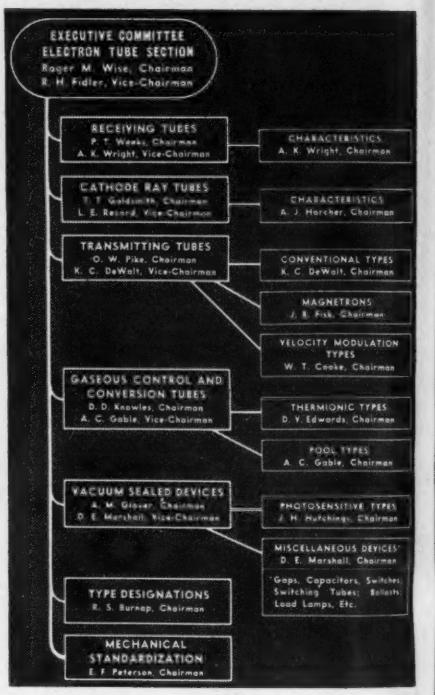
ASSOCIATION NEWS

RMA Tube Section Revised

The Electron Tube section of the Engineering department of the Radio Manufacturers Association has been somewhat revised to permit further expansion of the committee personnel. Dr. W. R. G. Baker is director of engineering and V. W. Graham assistant director of engineering. The revised organization is shown in the accompanying new chart.



Radio Planning Board Launched

Nine radio and electronic industry groups have now formally joined in the organization of a "Radio Technical Planning Board" to make studies to develop postwar radio services and products, along the lines of recent proposals coming from the FCC, RMA and IRE.

Preliminary organization of this RTPB technical advisory group, which will formulate recommendations to the Federal Communications Commission and other ex-government bodies concerned, was effected at a meeting of the nine groups on September 15, at the Roosevelt Hotel in New York City. Haraden Pratt of IRE and A. S. Wells of RMA acted as co-chairmen for the initial meeting.

Sponsors approve

The organization plan for RTPB, sponsored and presented jointly by the Radio Manufacturers Association and The Institute of Radio Engineers, was approved unanimously by the initially invited

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Because of the secrecy encircling war production, little can be told of a meter's importance to almost every phase of the work. Suffice it to say that over a wide range of industrial electronic applications . . . heat treating, counting, refining, sound detection, color selection, and many others about which not a word has been spoken or written . . . electrical measuring instruments are universally used.

It is of interest to know . . . for present and future reference . . . that DeJur precision meters are built into the equipment employed by many war plants. Wherever used, these meters enjoy confidence from the standpoint of sensitivity, durability and dependability. Peace will usher in even more new uses for meters. To insure absolute satisfaction, specify DeJur.

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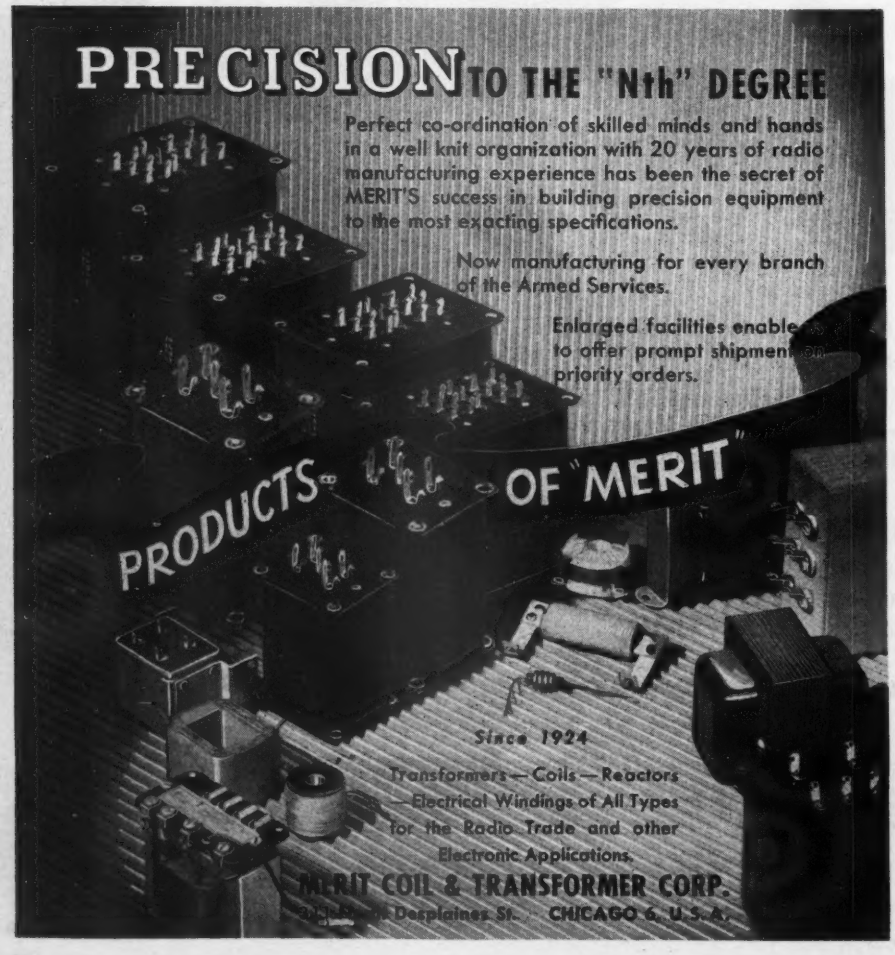
PRECISION TO THE "Nth" DEGREE
Perfect co-ordination of skilled minds and hands in a well knit organization with 20 years of radio manufacturing experience has been the secret of MERIT'S success in building precision equipment to the most exacting specifications.
Now manufacturing for every branch of the Armed Services.
Enlarged facilities enable us to offer prompt shipment on priority orders.
PRODUCTS OF "MERIT"
Since 1924
Transformers — Coils — Reactors — Electrical Windings of All Types for the Radio Trade and other Electronic Applications.
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"sponsors." These included, in addition to the RMA and IRE, the following:

American Institute of Electrical Engineers
American Institute of Physics
American Radio Relay League
FM Broadcasters, Inc.
International Association of Chiefs of Police
National Association of Broadcasters
National Independent Broadcasters.

Other "sponsors" are expected to join RTPB later for work on many technical projects, including utilization of the broadcast spectrum and systems standardization for many public radio services, including television and frequency modulation.

Elections and assignments

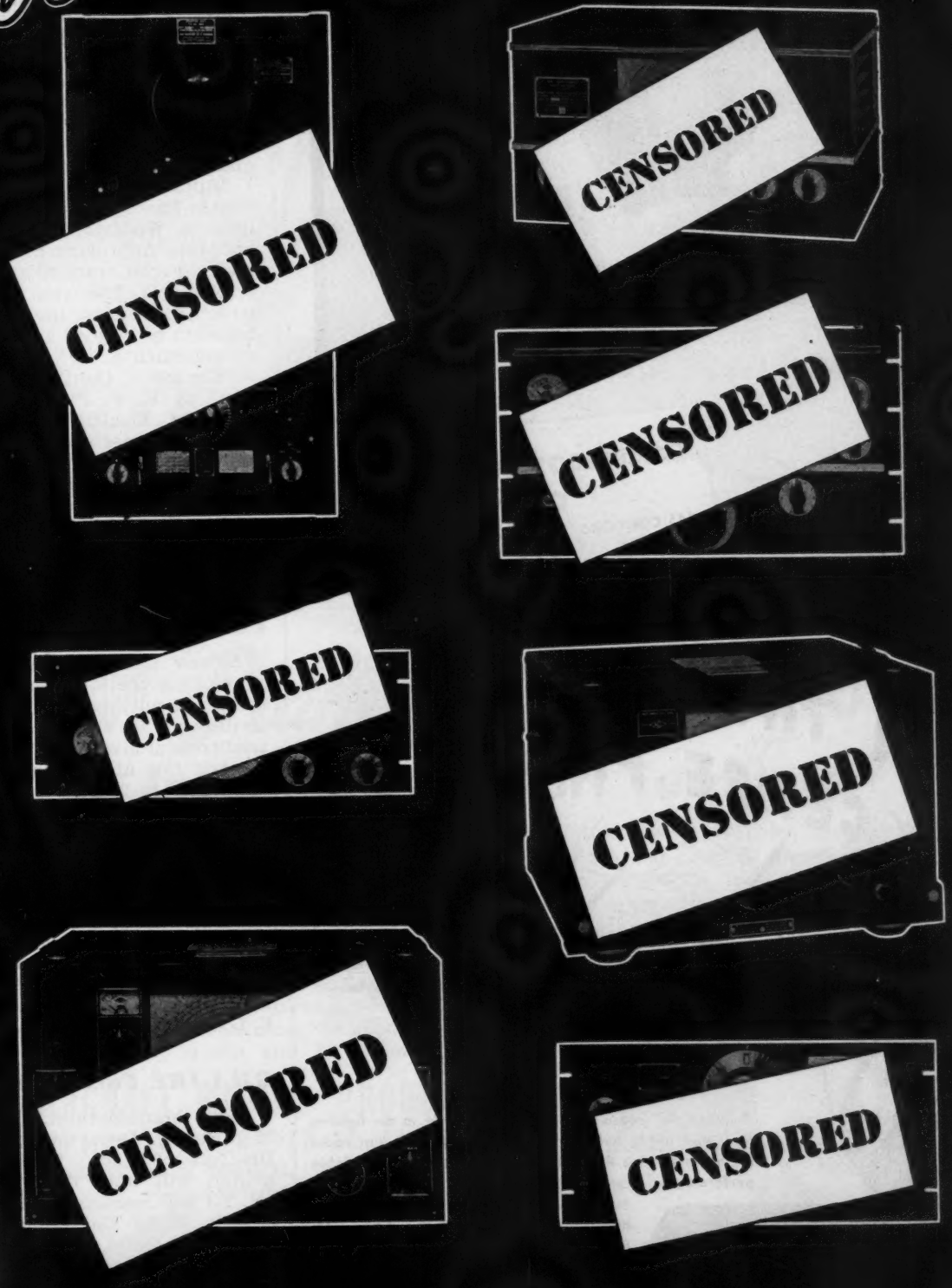
The general plan for organization of RTPB, approved unanimously at the New York meeting on September 15, was to be developed in detail at another meeting to be held in New York on September 29. Paul V. Galvin, president of RMA and Dr. Lynde P. Wheeler, president of IRE, issued the invitations for the meeting of September 29, called to arrange detailed panel and other organization procedures, including the election of a general chairman and officers.

Motion Picture Engineers Discuss Tube Applications

Application of electronic principles to the motion picture industry are to come in for a large share of the program for the fifty-fourth semi-annual technical conference of the Society of Motion Picture Engineers. The gathering will be held in Hollywood's Hollywood-Roosevelt hotel Oct. 18 to 22 inclusive.

Thirty technical papers have been scheduled for presentation. They cover a wide range of subjects, including acoustical research, sound recording, postwar television planning, new types of cameras, amplifiers and speakers. Among papers having to do more specifically with vacuum tube applications are: "Postwar television planning and requirements," by Klaus Landsberg, Television Productions, Paramount Studios; "An improved light valve checking device," by James P. Corcoran, Twentieth Century-Fox Studio; "Improvements in sound-recording equipments," by Dr. L. F. Brown, Western Electric Co. Dr. H. F. Olsen, research engineer of the RCA Laboratories will discuss acoustical research and another RCA engineer will describe recent sound recording installations in Washington, including RCA's 35 mm studio recorder.

For Our Uncle!



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MALDEN MASS., U. S. A.

★ When the "cease firing" order is flashed to our fighting men, we'll get to know in detail the vital part that radio played in winning the Victory. Then, the same dependable performance given on the battlefield by Sentinel-built equipment will be reflected in new peacetime models... models which will flow from Sentinel's factory lines, now fully utilized for war production. Then Sentinel dealers once again will be able to supply outstanding values in the radio and electronic field —battle-tested equipment in modern-as-tomorrow designs that will please and sell.

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2020 Ridge Avenue, Evanston, Ill.

★ ★ ★ ★ ★

Electronic Subjects Interest Electrical Engineers' Meeting

The following papers were among those presented at the National Technical Meeting of the American Institute of Electrical Engineers, September 2-4, at Salt Lake City, Utah.

"Radio Noise Elimination in All-Metal Aircraft" by Fred Foulon, Douglas Aircraft Co., El Segundo, Calif. Effective means to reduce radio noise due to the electric equipment of the plane were discussed.

"Application of 720-Cycle Carrier to Power Distribution Circuits" by J. L. Woodworth, General Electric Co. Approximate methods to evaluate the transmission characteristics of 720-cycle waves over power systems are investigated and found to be in good agreement with measurements.

"Electronic Control of D-C Motors" by K. P. Puchlowski, Westinghouse Electric and Mfg. Co. Some characteristics of a rectifier-motor system are investigated.

"Aircraft Transformers" by O. Kiltie, General Electric Co.

"Parallel Operation of Airplane Alternators" by D. W. Exner, Westinghouse Electric and Mfg. Co.

Control of Gas Cutters

A new means of electronically controlling the steering motor of a gas flame cutting machine was described by R. D. McComb, industrial control division of the General Electric Co., at the Chicago meeting (Oct. 18-21) of the American Welding Society. The equipment is a photo-electric template control in which the scanning motor is controlled in response to a signal from a scanning head. A new type of recording equipment designed to facilitate comparisons between a test weld and a weld made on the job was described by J. Van den Beemt and J. R. Fetcher of the E. G. Budd Mfg. Co.

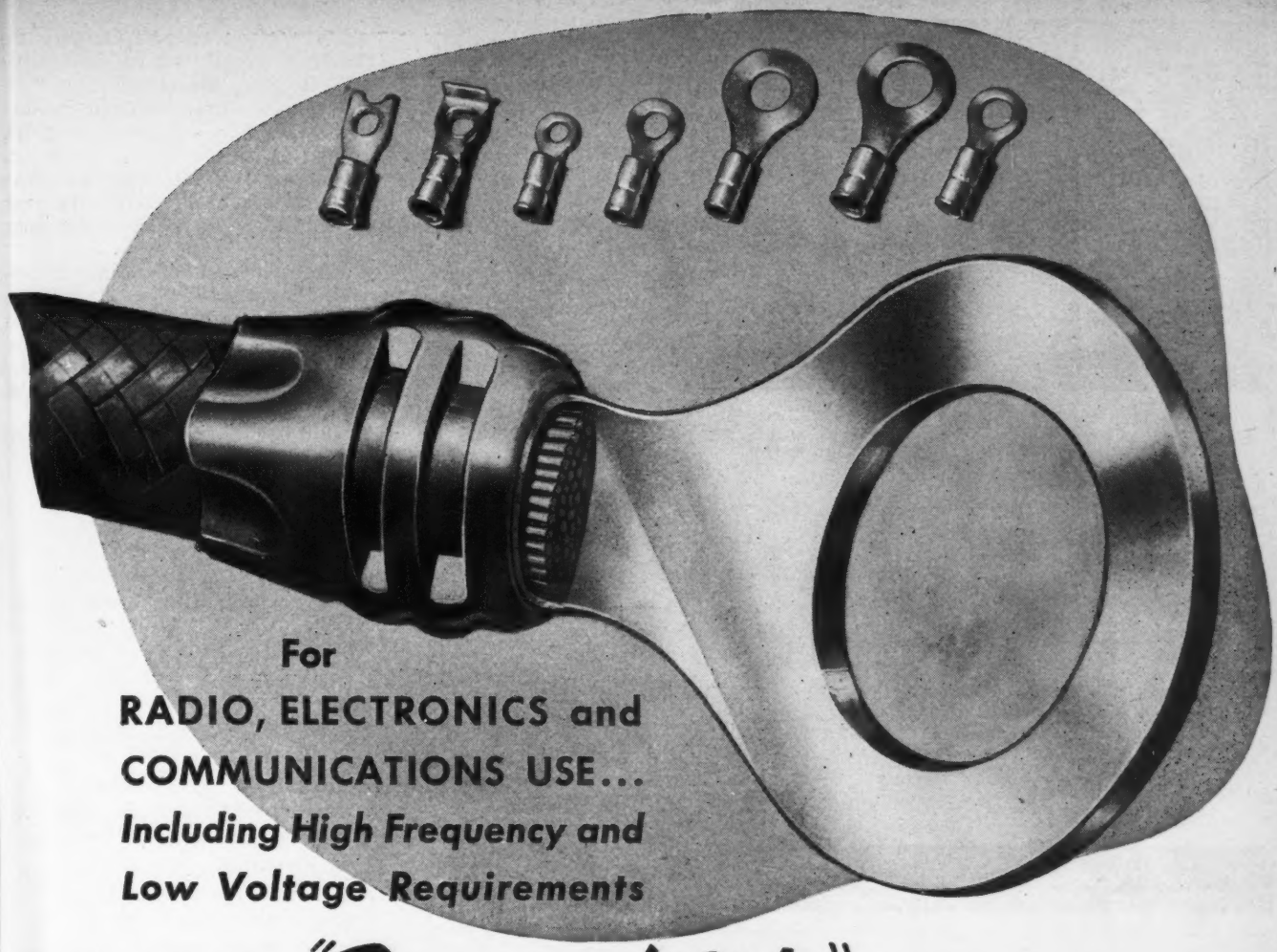
RMA-IRE Fall Meeting

Radio Manufacturers Association Engineering Department and the Institute of Radio Engineers, together, will hold their Rochester (N. Y.) fall meeting in the form of a War Radio Conference at the Sagamore Hotel, Nov. 8 and 9. Technical sessions will present the following papers:

Demountable vs. sealed-off tubes, by I. E. Mouromtseff, Westinghouse Electric & Mfg. Co.

Recent advances in Klystron theory, by William W. Hansen, Sperry Gyroscope Co.

Design of if transformers for FM modulation receivers, by William H.



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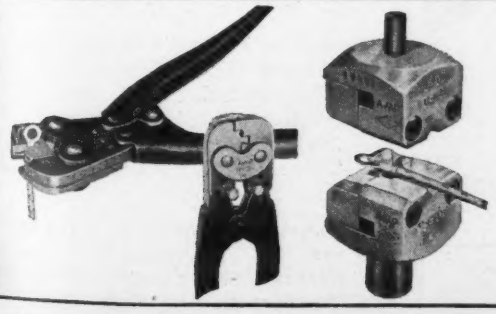

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Operating characteristics of ceramic dielectrics with constants over 1000, by R. B. Gray, Erie Resistor Co.

A Chamber of Commerce war research committee, by K. C. D. Hickman, Distillation Products, Inc.

New low-loss ceramic insulation, by Ralston Russell, Jr., and L. J. Berberich, Westinghouse Electric & Mfg. Co.

Design of if systems, by J. E. Maynard, General Electric Co.

Conventions and Meetings Ahead

Optical Society of America (A. C. Hardy, Massachusetts Inst. of Technology), Oct. 7-9, Pittsburgh.

Electrochemical Society (C. G. Fink, Columbia University, New York), Oct. 13-16, New York, Hotel Pennsylvania.

Radio Club of America (11 West 42nd Street, New York), Oct. 14, Columbia University, New York.

American Welding Society (Miss M. M. Kelly, 29 West 39th Street, New York), Oct. 18-21, Chicago.

Society of Motion Picture Engineers (Harry Smith, Jr., Hotel Pennsylvania, New York), Oct. 18-22, Hollywood.

American Physical Society (Karl K. Darrow, Columbia University, New York), Oct. 23, New York.

National Electrical Manufacturers Association (W. J. Donald, 155 East 44th Street, New York), Annual Meeting, Waldorf - Astoria Hotel, Oct. 25-29, New York.

Society for Measurement and Control (New York Section Meeting), Oct. 26, New York.

Society of Rheology (R. B. Dow, Aberdeen Proving Ground, Maryland), Oct. 29-30, New York.

New York Electrical Society (29 West 39th Street, New York), Nov. 4, New York.

American Institute of Chemical Engineers (50 East 41st Street, New York), Nov. 14-16, Pittsburgh.

American Institute of Electrical Engineers (H. H. Henline, 29 West 39th Street, New York City), Southern District Meeting, Nov. 16-18, Roanoke, Va.; National Technical Meeting, Jan. 24-28, New York.

National Association of Manufacturers (G. G. Geddis, 14 West 49th Street, New York), Dec. 8-10, Waldorf-Astoria Hotel, New York.

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NEW BOOKS

Electrical Engineering, Basic Analysis

By Everett M. Strong, Prof. of Electrical Engineering, Cornell University. Published 1943 by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City. Approx. 400 pages, with many illustrations. Price $4.00.

This book, at first glance, seems to differ in its scope from the usual textbook found in an electrical engineering course, since it practically avoids discussing of equipment details and operating procedures that deal with this field. Instead, it takes up in a particularly thorough manner, the matters usually found in a physics textbook, in the chapter on electricity.

A more detailed examination shows that the scope of this text is that of training engineers in the fundamentals of the work. It might be considered as the antithesis of a reference book, where the answers to the usual type of problems are spread out, so that if the project at hand happens to fit into one of the Tables, the need for any further information is superfluous.

The author follows the opposing system, which calls for a complete course in the basic concepts. This seems an excellent plan since the mathematical analysis of a problem can be handled only when the user can lay out the necessary conditions so as to set up the equations. The author ably presents these concepts with a clarity rarely attempted in tests, where in too many cases the fundamentals are covered in a few pages at the start. It is believed that engineers graduating with the intimate knowledge of essentials will have a much improved chance of working out problems encountered, which in practice have an exasperating tendency to be just a little different from these taken up in a classroom or described in a Handbook.

Reference Data for Radio Engineers

Published by Federal Telephone and Radio Corp. (an I. T. & T. associate), 67 Broad St., New York City. 200 pages. Price $1.00 per copy. 12 or more will be filled at 75c per copy.

This book, a compact radio handbook is presented as an aid in radio research and development, as well as in factory and field engineering. The aim of the compilers has been to provide for the requirements of engineers as well as practical technicians. Hence, more fundamental information is included than is usually found in a pocket-sized

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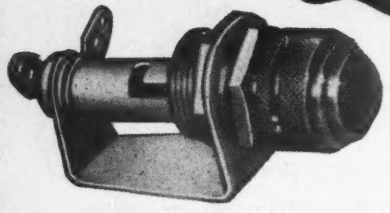

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Experiments in Electronics and Communication Engineering

By E. H. Schulz and L. T. Anderson, both of the Illinois Institute of Technology, Chicago. Published (1943) by Harper & Brothers, New York City. 381 pages. Price, $3.00

A guide to laboratory experiments and methods in the measurements and processes commonly used in electronic and ultra-high frequency radio technic. It is important that the persons starting the study of electrical and radio methods become acquainted with actual equipment and the ways with which it can be handled and tested, early in the course. This manual containing more than one hundred well selected and described laboratory experiments, will provide an important part of any training program.

Electronic Control of Reistance Welding

By Geo. M. Chute, Application Engineer, General Electric Co. Published by McGraw-Hill Book Co., New York City, 1943. 389 pages. Price $4.00.

A practical manual on the operating principles of welding control in all its phases. The treatment is thorough and can be used by engineers and operators alike in studying process control for which it provides a useful introduction to the use of electron tubes in timing problems.

Electronic Physics

By L. Grant Hector, Herbert S. Lein and Clifford E. Scouten. Published by the Blakiston Co., Philadelphia, 1943, 355 pages, $3.75.

Intended as an elementary textbook for college courses in electronic processes and associated fields, the book gives a short survey of the various subjects treated. Chapters on ac circuits, electrolysis, batteries, magnetism, dc and electron tube circuits, geometrical optics, photoelectricity and radioactivity are included.

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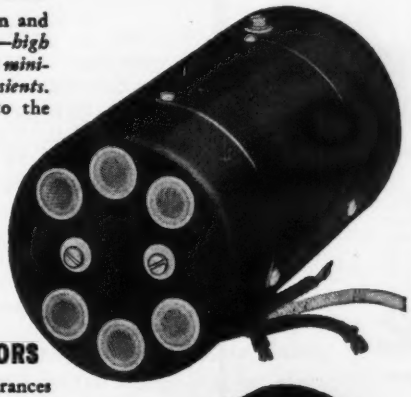

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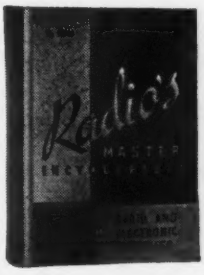

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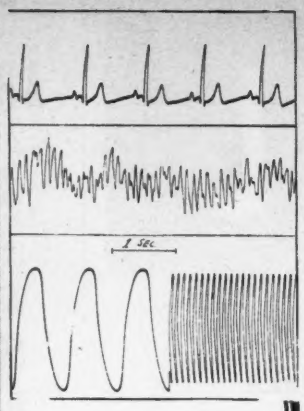

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First Principles of Radio Communications

By Alfred P. Morgan, published by D. Appleton Century Co., New York, 1943. 353 pages, $3.00.

Living up to its title, this is a readable book for the layman who wishes to acquire a basis for technical study of communications electronics. Starting from scratch, the first half of the book deals with electrical fundamentals by means of mechanical analogies and simplified electrical schematics. The author next takes up vacuum tube operation and applications to receiving and transmitting circuits.

NEW BULLETINS

Pressed Steatite Pieces

As a practical contribution to speedier steatite production, Henry L. Crowley & Co., 1 Central Ave., West Orange, N. J., has issued a detailed listing of standard pressed steatite parts for which tools are already available. The listings are in the form of detailed and dimensional drawings of bushings, trimmer-condenser bodies, terminal strips, tube sockets, tube parts, coil bases, variable-condenser end pieces, oscillating-crystal cases, etc., with corresponding part numbers. Well over a hundred standard parts are listed, with more to follow in supplementary bulletins issued from time to time.

Ballast for Fluorescent Lamps

A new 4-page bulletin has been released by Industrial Electronics Corp., 951-63 McCarter Highway, Newark, N. J. It includes descriptions and diagrams of the new Magno-Tronic Ballast which has the patented, non-magnetic alloy "Perma-Gap" feature. These ballasts control the flow of current into the lamp within limits of one-half of one per cent, thus preventing the premature black ends and deterioration of the cathodes' emissive coating.

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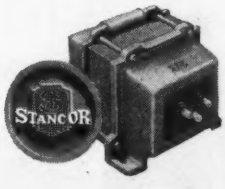

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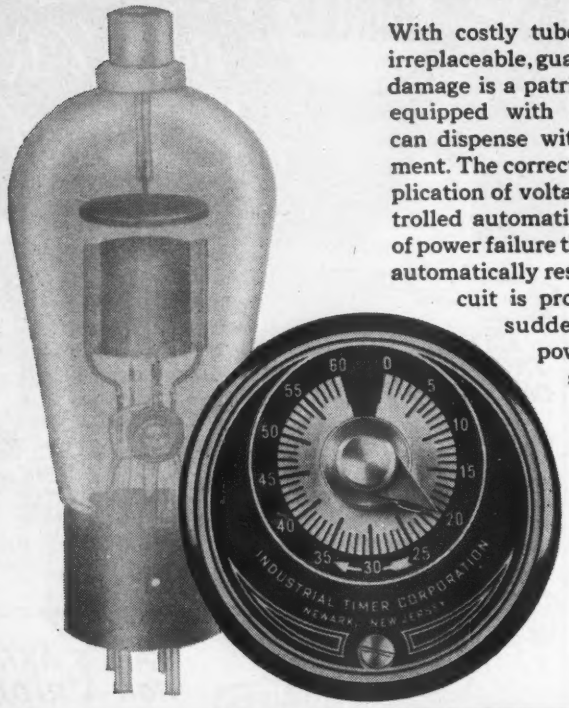

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Resistance Standards and Bridges

A new bulletin which describes and illustrates resistance standards and bridges has recently been published by Rubicon Co., Ridge Avenue at 35th St., Philadelphia, Pa. New items include a portable bridge, high precision bridge, Mueller bridge and decade resistance assemblies.

Insulation Testers

James G. Biddle Co., 1211-13 Arch St., Philadelphia, has released bulletin No. 1735 describing Megger insulation testers. The cases are molded of high-impact phenolic material and all joints are dustproof. The folder shows various pictures of the device with its parts disassembled and an internal circuit diagram and chart showing terminal voltage characteristics of a 500-v, 100-megohm instrument are included.

Felt in Industry

Felt Facts is a new booklet just issued by the Felt Association, Inc., of New York. It tells the story of the manufacture and of some of the myriad uses of wool felt.

Attention is called to the many applications of felt in engineering and mechanical fields as an alternate for rubber, cork, certain fabrics and plastics, and other priority materials. The importance of wool felt in improved technique vibration-isolation, filtering, grinding and polishing, and other processes ranging from minute filters in tiny hypodermic needles to block-buster washers and padding for eighty-ton tanks, is revealed. The modern manufacture of this oldest of fabricated fibre material, is interestingly portrayed in sixteen drawings by the noted artist, Helene Carter. Copies may be obtained gratis by addressing Korbel & Colwell, Inc., 480 Lexington Avenue, New York 17, N. Y.

Automatic Timers

A new condensed catalog, describing the functions of the many different types of timers, their application and usage, has recently been published by the R. W. Cramer Co., Centerbrook, Conn.

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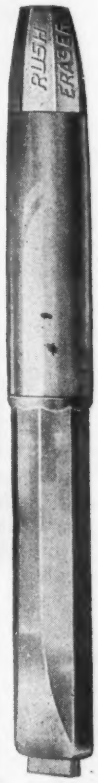

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In manufacturing headsets for the use of our fighting forces, the main thing is to be certain each one is as perfect as it is possible to make it.

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Connecticut has been identified with "communications" for half a century. It has never been known as the largest, but always as among the very best, in design, engineering, and precision production. If your post-war plans involve the use of precision electrical devices, in connection with product development or production control, perhaps we can help you eliminate the "question marks".

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Our September Front-Cover Girl

Editor, Electronic Industries:

Delighted to inform you that your September front cover has received honor award in the National Magazine Cover Competition on the theme of "Women in Necessary Civilian Employment."

The Museum of Modern Art
11 West 53 Street
New York City

Tone-Control Relay

Several inquiries have been received from readers concerning the Tone-Control Relay shown at Item 27 on the chart, "The Electron Tube as an Element of Industrial Control," appearing in our August issue.

"The Tone Control Relay referred to on the chart," explains Consulting Editor, Ralph R. Batcher, author of the chart, "is a device which has been used by the writer for some years as a signal indicator. The theory is that the tube amplifies any signal that is applied and which is then rectified and returned as a bias on the amplifier tube. The rectifier load is high, a one-megohm variable resistance being suitable, when a 6R7 is used, shunted by a capacitor whose value had best be determined by experiment.

"As long as the signal level is greater than an amount sufficient to supply the losses in this grid leak, the relay will stay released. Upon loss of signal, the condenser will discharge and the tube re-operate. Ordinary audio transformers can be used here.

"I do not know that this principle has ever been published before."

Dr. de Forest Climbs 14,495 Ft. at 70

Dr. Lee de Forest, who has just celebrated his 70th birthday, continues so active physically, that three times during the present year he has climbed 14,495-ft. Mt. Whitney, near his Los Angeles home. For several years past, Dr. de Forest has made it a ritual on each birthday anniversary to scale Mt. Whitney which is the highest mountain in the continental United States.

Welsh Adds Molding

Wm. H. Welsh Co., 2241 Indiana Ave., Chicago, long a manufacturer of speaker diaphragms and pressed products, has added compression molding. The company is now in production on a contract for plastic ear phones.

Simonds Resumes Consulting

Until recently eastern technical director of the Plastics Industries Technical Institute, J. Earl Simonds has resumed his consulting practice with offices at 122 E. 42nd St., New York. He will specialize in analysis and commercial aspects of new plastic and resinous materials, plant layout and installation, new applications and technics, etc.

Chicago Parts Manufacturers Elect Officers

At its August luncheon meeting held at the Electric Club of Chicago, the Association of Electronic Parts and Equipment Manufacturers, which bands together over fifty manufacturers of radio and electronic equipment located in the Middle West, honored its executive secretary, Kenneth C. Prince, who attended his last meeting before leaving for Princeton University, where he will begin his training as a lieutenant (jg) in the U. S. Navy. A large decorative cake was presented in honor of the occasion.

Lt. Col. John M. Niehaus, Labor Officer, U. S. Army Signal Corps, and Albert A. Epstein, Assistant Director of the Sixth Regional War Labor Board, addressed the members and explained the functions of their respective offices in connection with labor problems and wage stabilization matters.

An election of officers for the ensuing year returned P. H. Tartak, president of the Oxford-Tartak Corp., Chicago, chairman of the Association. E. G. Shalkhauser, president of Radio Manufacturing Engineers, Inc., Peoria, was named vice-chairman. Miss Helen A. Staniland, vice-president of Quam-Nichols Co., Chicago, was re-elected treasury. Lewis G. Grobe, associated with Mr. Prince in the practice of law, was elected secretary pro tem and will perform the functions of Executive Secretary pending the return of Mr. Prince.

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• Not only have savings in the amount of steam consumed been made possible, but the company also says: "We have, in addition, improved circulation of steam to the various types of radiation and are able to maintain any desired temperature in any space." Reminding you that Flashtron is not a control "system", but rather the "Heart" which makes possible the more accurate regulation of various elements occurring in manufacturing and analytical processes, we invite manufacturers of controls to send for brochure giving detailed information including diagrams showing how Flashtron operates in a typical control installation.

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Carter Motor Co. Chicago, Illinois

1606 Milwaukee Ave. Carter, a well known name in radio for over twenty years. Cable: Genemotor

Airplane Relay of Broadcasts to Enemy Countries

In the section headed "Unbiased" of the Wireless World, London, July, 1943, a new method is suggested to provide radio broadcasts for listeners in enemy countries.

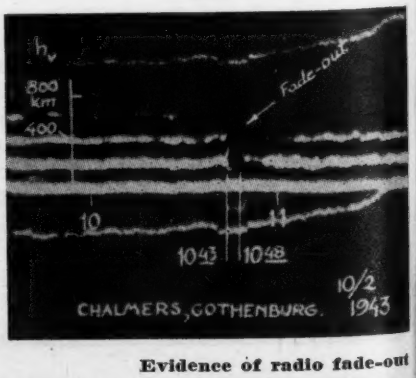
It is proposed to install a low-power transmitter in an airplane flying at a stratospheric height. "These radio bombers would literally be able to force the programs on to the Volksempfaengers, the very small unselectiveness of which making this all the easier to accomplish." The studio could still be in London, with one transmitter used to link it up with a short-wave receiver in the tail of the plane which would rebroadcast the programs.

On Radio Fade-Out and Sunspots

In the June 19, 1943 issue of "Nature," O. E. H. Rydbeck of the Chalmers Institute of Technology, Gothenburg, Sweden, reports the following observations:

On February 10, 1943, the Prague Observatory reported strong, brilliant sunspot eruptions. On the same day, the Chalmers Ionospheric Observatory registered a radio fade-out between 10.43 and 10.48 local time as shown by the recording. The frequency used was 2.93 mp./s. It is interesting to note that an oblique incidence double pulse (from a distant sender) was recorded at the same time, as shown by the lowest pattern. During the fade-out, starting and ending before and after it, the recorded double pulse was apparently reflected from the region of abnormal ionization below the regularly reflecting layer. Finally, it should be remarked that the magnetograms showed no conspicuous change at the time of the fade-out.

In order to find out whether the fade-out had any connection with the sunspots or not, the Chalmers Observatory would like to receive observations from the observatories in the sun-lit hemisphere.



Evidence of radio fade-out

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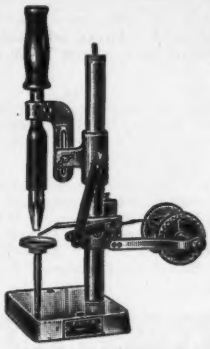

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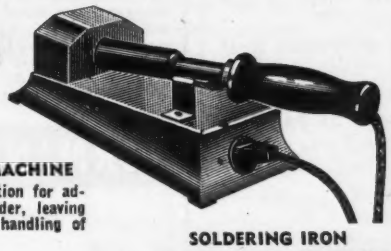

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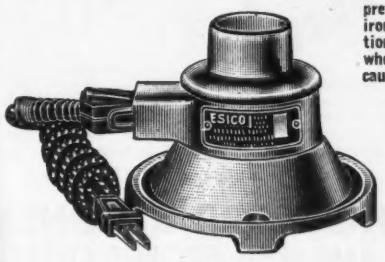
prevent overheating of soldering irons between soldering operations. Irons do not deteriorate when being used. The idle period causes oxidation and shortens life.



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see advertisement, page 130

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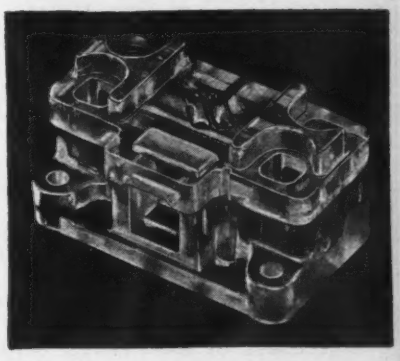

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MILESTONES TOWARD THE ELECTRONIC ERA

The First Cathode Ray Tube?

What may well be a description of the first cathode ray tube appeared in print some 93 years ago in connection with the details of an experiment that was set up to prove the hypothesis of the aurora borealis. Many years later much further work along these lines was done by Stormer using very low speed cathode rays, and at that time, heated cathodes. Incidentally, many readers may not be aware of the similarities between the northern lights and the cathode rays of the television tube, so this glance backward nearly a century may be of interest:

Influence of magnetism

"A memoir by Morlet on the aurora borealis induced M. de la Rive to communicate to the Paris Academy the following experiment, showing the influence of magnetism on the light produced by ordinary electrical discharges. 'I introduce into a glass globe, by one of the two tubulures with which it is furnished, a cylindrical iron bar, of such length that one of its extremities reaches nearly to the centre of the globe, while the

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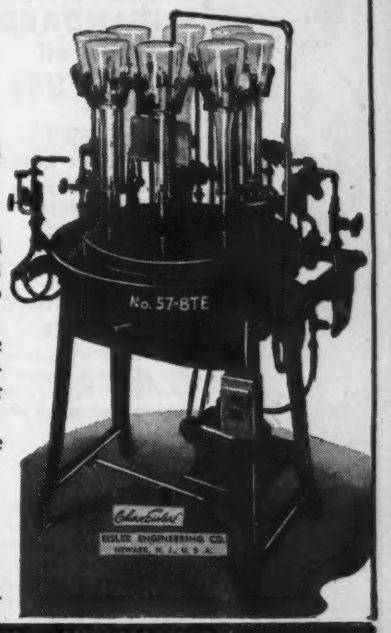

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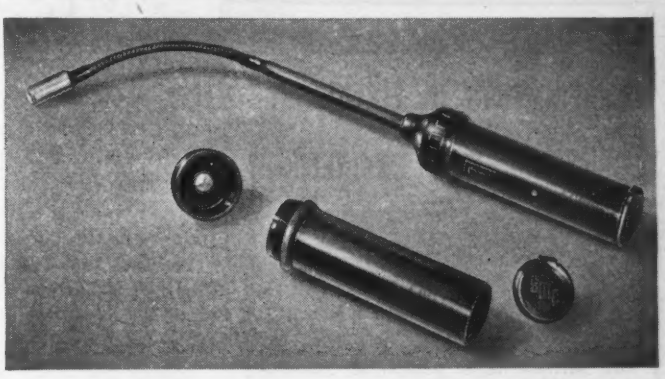

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other extends a short distance out of the tubulure. The bar is hermetically sealed in the tubulure, and covered throughout its length, except at its two ends, with an isolating and thick layer of wax. A copper ring surrounds the bar above the isolating surface in its internal part the nearest to the side of the globe; from this ring proceeds a conducting rod, which, carefully isolated, traverses the same tubulure as the iron bar, but without communicating with it, and terminates externally in a knob.

"'When, by means of a stopcock adjusted to the second tubulure of the globe, the air in it is rarefied, the knob is made to communicate with one of the conductors of an electric machine, and the external extremity of the iron bar with the other, so that the two electricities unite in the interior of the globe, forming between the internal extremity of the iron bar and the copper ring which is at its base a more or less regular fascicle of light. But if the external extremity of the iron bar is placed in contact with one of the poles of a strong electro-magnet, taking good care to preserve the isolation, the electric light takes a very different aspect.

Electrical egg

"'Instead of issuing, as before, from the different points of the surface of the terminal part of the iron bar, it is emitted only from the points which form the contour of this part, so as to constitute a continuous luminous ring. This is not all; this ring and the luminous jets which emanate from it have a continuous movement of rotation around the magnetized bar, now in one direction, now in another, according to the electric discharges and the direction of the magnetization. Lastly, more brilliant jets appear to issue from this luminous circumference, without being confounded with those which terminate on the ring and from the fascicle. As soon as the magnetization ceases, the luminous phenomena becomes again what it was previously, and what it is generally in the experiment known as the electrical egg.'

"This experiment appears to account very satisfactorily for what passes in the phenomena of the aurora borealis; in fact, the light which results from the union of the two electricities in the part of the atmosphere which covers the polar regions, instead of remaining vaguely distributed, is carried by the action of the terrestrial magnetism round the magnetic pole of the globe, whence it seems to rise in a revolving column, of which it is the

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base. We thus understand why the magnetic pole is always the apparent center whence issues the light constituting the aurora borealis, or towards which it appears to converge."—Silliman's Journal, May, 1850.

Some Radio and Light Analogies

By David Grimes
Vice-president Philco, Inc.

The untimely death of Dave Grimes in an airplane crash overseas is reported on page 204 of this issue. Earlier in the summer, Mr. Grimes had given the following delightful discussion of radio principles before the N. Y. Institute of Finance, injecting characteristically some new relationships and angles which most radio men may have overlooked.

Light is an electro-magnetic wave. There is no difference between the light you see with your eye, coming out of these lamps, and the radio wave which brings you your program from the local broadcasting station. I say "no difference whatever," that is, outside of the fact that the waves coming to you from the broadcasting station are created by electrons that vibrate slowly in the antenna, so that the waves are long waves, while the waves coming to you from an atom (light waves) are short waves—very, very short!

When we want to pick up one of these electro-magnetic waves that have been generated by whatever source, we try to select an antenna of the same comparable dimensions as the antenna where the original wave was created. We call that resonance. You have similar resonance in a piano or any musical instrument. If you put your foot on the loud pedal of a piano and sing into the piano, whatever note you sing, the piano will respond back to you. Put your foot on the loud pedal, take the felts away from the strings, and sing into the piano, and whatever note you sing, the string for that note will be set into vibration by your own vocal chords, and the string will answer you back.

Short paths, high frequency

So when we are receiving any wave and want the electrons to be set up in our receiving apparatus so that they will start vibrating of their own free will, we choose an antenna of about the same length

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as the transmitting antenna; we set up the circuits so they are about the same length electrically. Thus, when we get up to ultra high frequencies, our receiving antenna is short because the transmitting antenna is short, the electrons are vibrating rapidly in a short distance, and the electrons of the receiver are sped up in resonance.

I would like to speculate, for a moment, as to what our mechanism of vision comprises. In the complex structure of the rods and cones in the back of your eyes you have atomic resonance circuits of some sort—or atomic resonance—so that these ultra micro micro waves (light) coming from the electrons within the atoms, set up the vibration of the electrons within your eye structure, creating a sensation of light.

Great big eyes!

Now, we might travel from that to visualize, for a moment, what would happen if our eyes were bigger. Suppose our eyes were so large that the rods and cones could resonate to the broadcast frequency. I wouldn't want to say how big those eyes would be, but suppose, for a moment, in order to draw on our imaginations, we had eyes big enough to see the broadcast frequencies, the waves sent out from the broadcast stations. Then each and every one of these broadcast stations would appear to be a huge lighthouse. WJZ would send out, up and down, these waves of light. You would see that light. It would have a distinctive color. I don't know what color it would be, because I have never "seen" those colors.

Those waves would go out, and no matter how far away you went, the station would be that same color. If WJZ should be "blue" at the transmitter, it would be blue a hundred miles away; and of course, after you got beyond the line of sight, or the horizon, you would see WJZ as a blue reflection in the sky, much like you see the sunset long after the sun has gone down beyond the horizon; you would see the light reflected on the clouds or the lighter layers of air.

Bye, bye, Wall Street!

If you looked around here in Wall Street with those big eyes just mentioned, you wouldn't see any people. For people would all be transparent; the buildings, too, would be very largely transparent, as if they were built of glass brick.

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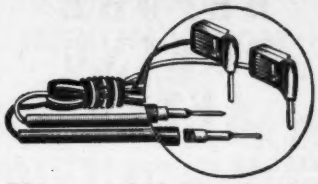

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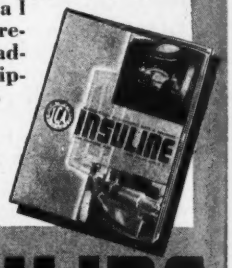

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But the steel ribs in the buildings, all the steel work, would stand out opaque, because steel is impervious to these long waves, broadcast waves. You might wonder. It might be hard for you to understand how these broadcast waves can go right through a wooden or plastic wall, and yet you can't put your fist through the wall. But it is no more wonderful than that light can go through the glass windows because of the structure of the molecules within the glass, and yet you can't put your fist through it very readily.

Then, as you looked around, (still with your big eyes), you would see automobiles going up and down the street, traveling maybe four or five inches above the translucent pavement, because you wouldn't see any rubber—(and you won't see any rubber, anyway, in another year or two). You wouldn't see it with these radio eyes of yours.

I think we are probably ready now to discuss philosophically how AM operates, and then discuss philosophically what FM is in the picture I have just painted. I am going into no circuits, no details.

If this WJZ broadcasting station had a program on it, and your eyes were tuned to the broadcast band, big ones, and your eyes were quick enough, you would see a flicker occurring on this beam of blue light that I referred to as WJZ. The flickers would be the program emanating from the broadcast studio. Flickers would appear on the program sent out by the announcer or by the piccolo player or by anybody who happened to be in front of the microphone. It would be a flicker in the blue light, from very intense blue to very dim blue, but it would be the same shade of blue.

FM is essentially a system of modulation whereby, instead of the light being increased and decreased in **intensity** as you put the program on the air, the **color** of the light beam is changed.

You still have these broadcast eyes, now, so to speak; you are still seeing these beams of light; you are still seeing these radiations, for the moment, and so the color of an FM station, the color of its beam would change as the program was put on in the studio. The color would switch back and forth, from light blue to deep blue, or from cobalt blue to deep blue. That is it would shift back and forth in **color** but **not** in brilliance or intensity.

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